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Research Product 90-19B

Hardware vs. Manpower Comparability Methodology

**Step 1: Systems Analysis
Volume 2**

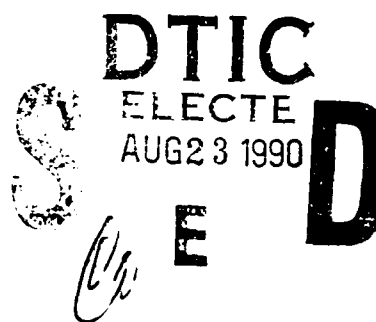
May 1990

**Manned Systems Group
Systems Research Laboratory**

U.S. Army Research Institute for the Behavioral and Social Sciences

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➤ This volume deals with systems analysis, which establishes the foundation for the entire HCM analysis. Systems are defined; equipment hierarchies are established; missions, functions, and usage rates are determined; operator and maintainer tasks are identified; and reliability and maintainability (R&M) characteristics are determined.

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Hardware vs. Manpower Comparability Methodology

Step 1: Systems Analysis Volume 2

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FOREWORD

The goal of the Army HARDMAN methodology is to provide timely information on the manpower, personnel, and training (MPT) resource requirements of emerging weapon systems. This information supports decisions on the research, development, and acquisition issues affecting emerging systems, as well as planning required for effective supportability of these systems in MPT and logistics areas. HARDMAN is a key element of the Army MANPRINT program.

This guide consists of seven volumes, a manager's guide and one volume for each of the six steps of the HARDMAN methodology. The manager's guide is intended for the use of the manager in the planning, scoping, and costing of the HARDMAN analysis. The other six volumes are for the analysts who will perform the analytic procedures in each step of the methodology.

This volume is the manager's guide. It deals with the planning and conducting of the HARDMAN analysis and the estimation of the resource requirements for the analysis. Development of the quality assurance plan and the consolidated database are explained. The relationship of HARDMAN results to various Army MPT documents is also discussed.

This guide is a major revision and expansion of the existing five-volume HARDMAN guide. The scope has been altered to include procedures for assessing combat damage workload and depot-level manpower requirements, and estimating training resource requirements associated with new training concepts and other procedures not included previously. Existing procedures have been clarified, simplified, or expanded to make them more useful to the analyst and to make HARDMAN a more effective tool for the Army.

The development of the guide was part of the System Research Laboratory's Third Generation MANPRINT Estimation Research Task. Most of the expansion and enhancement of the HARDMAN method has been based on recommendations of the Soldier Support Center, National Capital Region (SSC-NCR), which has overseen application of the method to numerous Army weapon systems. Staff from the SSC-NCR attended all the in-progress reviews for this effort and have been briefed on the final product. In addition, personnel from the TRADOC Analysis Command, White Sands Missile Range, TRADOC Headquarters, the U.S. Army Human Engineering Laboratory, and other Army agencies have been briefed on the revised HARDMAN guide to make them aware of its enhanced capability to provide MPT information for emerging systems.



EDGAR M. JOHNSON
Technical Director

HARDWARE VS. MANPOWER COMPARABILITY METHODOLOGY (STEP 1: SYSTEMS ANALYSIS)
(VOLUME 2 OF 7)

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**HARDWARE VS. MANPOWER COMPARABILITY METHODOLOGY (STEP 1: SYSTEMS ANALYSIS)
(VOLUME 2 OF 7)**

INTRODUCTION

"Systems Analysis" is the first step in the Army HARDMAN Comparability Methodology (HCM). The HCM is a Manpower and Personnel Integration (MANPRINT) tool that addresses manpower, personnel, and training (MPT) issues associated with new or improved weapon systems.

This document is one of seven documents that contain the steps necessary to conduct an HCM analysis:

"Overview and Manager's Guide"

"Step 1: Systems Analysis"

"Step 2: Manpower Requirements Analysis"

"Step 3: Personnel Pipeline Analysis"

"Step 4: Training Resource Requirements Analysis"

"Step 5: Impact Analysis"

"Step 6: Tradeoff Analysis"

How this Document Is Organized

An HCM step consists of an overview and substeps. A substep contains an overview and action steps. Each action step includes a discussion of what the analyst will accomplish in the action step; procedures that describe, step-by-step, how to accomplish the action step; and examples that feature actual Army systems. The table on the following page summarizes the procedures an engineering analyst must undertake to accomplish this HCM step.

Worksheets are used extensively throughout the guide. These worksheets help the analysis team organize and format information and serve as an audit trail of the analysis. Blank copies of these worksheets are located at the end of each substep.

Each HCM step has its own unique appendices. These appendices include articles that provide additional information about the step; a list of acronyms; a glossary; a crosswalk between the HCM and the Man Integrated Systems Technology (MIST); and a crosswalk between the HCM and MPT-related Army documents, for example, Basis of Issue Plans (BOIPs) and the Qualitative and Quantitative Personnel Requirements Information (QQPRI). (Each step's appendix section does not include a list of references. The "Overview and Manager's Guide" includes a complete list of references for all seven volumes.)

Step 1's Substeps and Action Steps

In this Substep	The Analyst Will	By Completing this Action Step
1.1	Identify General Mission Requirements	Determine General System Missions
1.2	Identify the Predecessor System and the New System Concepts	Identify the Predecessor System Obtain New System Documents and Identify Design Concepts
1.3	Conduct New System Functional Analysis	Identify the New System Operational Functions Identify the New System Operational Functions (Alternative Method) Identify Non-Operational System Functions Determine New System Functional Requirements Allocate Functions
1.4	Establish the Generic Equipment Structure	Develop the Generic Equipment Structure
1.5	Identify Detailed Mission Requirements and Determine Usage Rates	Array New System Functions Over Time Identify and Sequence Mission Events Determine System Operating Metrics Determine Usage Rates

Step 1's Substeps and Action Steps (Continued)

In this Substep	The Analyst Will	By Completing this Action Step
1.6	Establish the Baseline Comparison System	<p>Identify BCS Components</p> <p>Evaluate Candidate BCS Components for Workload Analysis</p> <p>Evaluate and Select Candidate BCS Components for Training Analysis</p>
1.7	Establish the Proposed System	<p>Evaluate Existing Components and Contractor-Proposed Components/Designs</p> <p>Determine BCS Performance Deficiencies</p> <p>Develop Proposed System Equipment Structures and Determine Design Differences</p>
1.8	Determine Generic Tasks	<p>Determine Operator Tasks</p> <p>Determine Maintainer Tasks</p>
1.9	Determine Reliability and Maintainability Requirements	<p>Determine Predecessor System R&M Requirements</p> <p>Determine BCS R&M Requirements</p> <p>Determine Proposed System R&M Requirements</p>

STEP 1 SYSTEMS ANALYSIS

Overview

In Systems Analysis, the first step of the HARDMAN Comparability Methodology (HCM), the engineering analyst establishes the foundation for the entire analysis by defining the New System, Predecessor System, Baseline Comparison System (BCS), and Proposed System. Figure 1-1 is an overview of this step.

One of the analyst's major objectives in Step 1 is to define the New System, that is, the weapon system being studied. In the first two substeps the analyst identifies the New System's missions and design concepts. In Substep 1.2, the analyst also defines the Predecessor System, i.e., the system being replaced. The analyst should conduct Substeps 1.1 and 1.2 simultaneously because they require many of the same data sources.

After the analyst has identified the New System's missions, he or she determines its functions and performance goals in Substep 1.3. The analyst then determines whether each function will be performed by system hardware or software and whether a human (operator, supporter, or maintainer) will be involved.

In the fourth substep the analyst develops a hierarchy of generic equipment that takes into account each New System function assigned to the hardware and software. The engineering analyst must work closely with the manpower and training analysts to develop a comprehensive hierarchy.

The analyst's objective in the fifth substep is to divide the New System's missions into functions and mission events and determine the New System's usage rates.

In the sixth and seventh substeps the analyst develops the Baseline Comparison System (BCS) and projects the Proposed System. The BCS is a composite of existing systems that attempts to meet the New System's requirements. The Proposed System is an analytical construct that performs all the New System functions and meets all New System performance standards.

The analyst's goal in the eighth substep is to identify generic operator and maintainer tasks for the New System functions that have been assigned to humans.

In the final substep the analyst determines the reliability and maintainability (R&M) characteristics of the Predecessor System, BCS, and Proposed System. These R&M characteristics are described in terms of a maintenance ratio (MR) of maintenance man-hours per operating metric (e.g., hours, rounds, miles). Maintenance ratios are an important input to the manpower workload analysis in Step 2.

Step 1 requires extensive data collection and analysis. The engineering analyst should begin to collect data early in the analysis to avoid costly delays. He or she should first determine Step 1's data requirements by examining the analysis scope, briefly reviewing each of the substeps, and consulting HCM subject-matter experts. Table 1-1 lists some of the data sources used in Step 1.

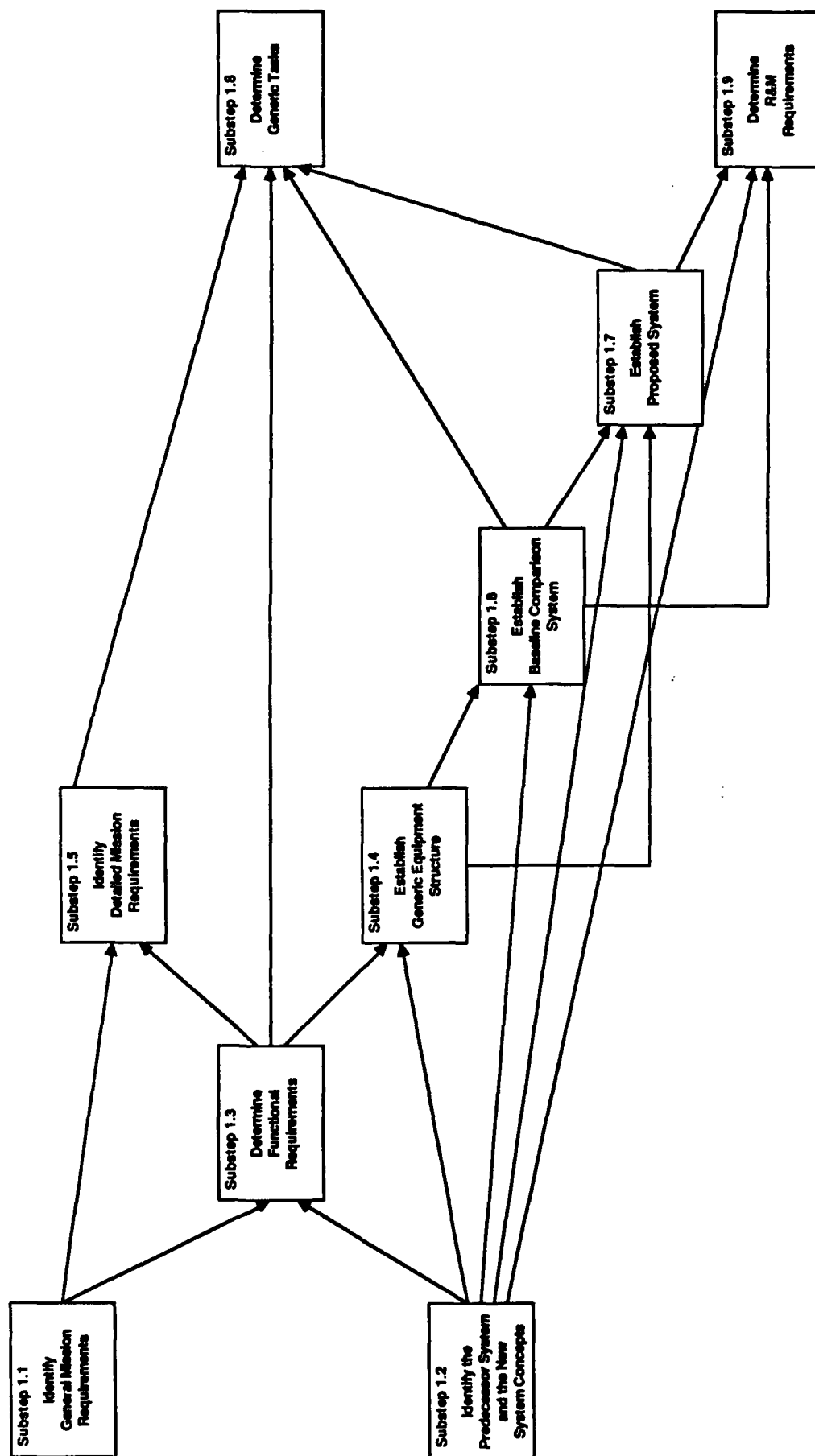


Figure 1-1. Overview of Step 1, Systems Analysis.

Table 1-1. R&M Data Sources

Data Source	Reliability Data		Maintainability Data	
	Inherent	Induced	CM	PM
Actual Field Data				
• Army SDC	X	X	X	X
• Navy 3M	X	X	X	X
• Air Force 66-1	X	X	X	X
Controlled Field Data				
• Army RAMLOG	X	X	X	X
• Operational Tests	X	X	X	X
Other Sources				
• Army Manpower Requirements Criteria (MARC)	X		X	
• Logistic Support Analysis Record (LSAR)	X		X	X
• The Army Maintenance Management System (TAMMS)	X	X	X	X
• Depot Systems Command (DESCOM) Master File of Maintenance (MFM)	X	X	X	X
• Major Subordinate Commands, e.g., AVSCOM 2410 data base	X	X	X	X
• Developmental Tests	X		X	X
• Engineering Estimates	X		X	X
• Subject Matter Experts	X	X	X	X
• Technical Documentation	X		X	X

Substep 1.1: Identify General Mission Requirements

Overview

The analyst's objective in this substep is to identify the New System's general mission requirements. The analyst obtains these general mission requirements from New System documents and generic mission lists categorized by system type. Figure 1.1-1 is an overview of this substep.

A system's mission requirements are best described as the system's purpose. Missions should represent the system's ultimate purpose, not intermediate steps leading to that purpose. Missions are stated in a manner that logically leads to system functions and eventually to the activities (tasks) required to perform those functions.

Missions will usually be stated in the Justification for Major System New Start (JMSNS) and/or the Letter of Agreement (LOA). Other sources include the Mission Area Analysis (MAA) for the system's mission area, the Organizational and Operational (O&O) Plan, the Required Operational Capability (ROC), and the how-to-fight field manuals (FMs) for the system's mission area.

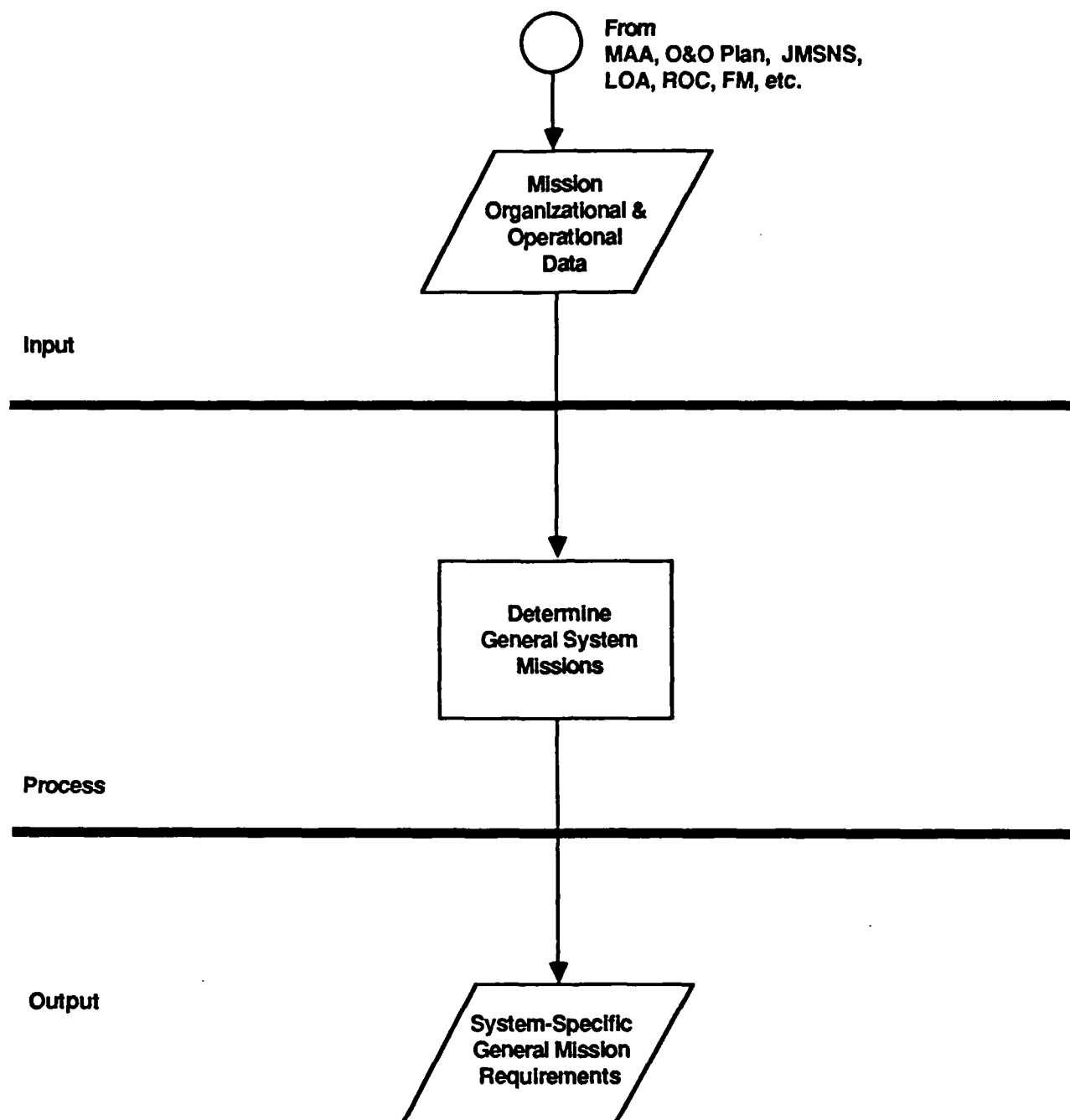


Figure 1.1-1. Overview of Substep 1.1, Identify General Mission Requirements.

Action Step 1: Determine General System Missions

Discussion

In this action step the analyst reviews the generic mission list for the system type under analysis. Using this generic mission list and the New System documents, the analyst determines the New System's general mission requirements and reviews these requirements with the HCM analysis sponsor or the Technical Advisory Group (TAG).

Procedures

1. **Obtain the New System Documents.**
 - Obtain the following documents:
 - Justification for Major System New Start (JMSNS);
 - Mission Area Analysis (MAA) (when available);
 - Operational and Organizational (O&O) Plan;
 - Required Operational Capability (ROC);
 - Letter of Agreement (LOA); and
 - How-to-fight field manuals.
2. **Identify the Appropriate System Type.**
 - Select from Table 1.1-1 a system type that is appropriate for the New System.
 - Record the system type on Worksheet 1.1-1.
3. **Refine the Generic Missions Associated with the System Type.**
 - Study the generic missions listed under the system type on Table 1.1-1.
 - Delete any generic missions that do not apply to the New System and add any missions required by the New System that are not listed in the table.

Table 1.1-1. System-Type Missions ¹

Usually, a New System will fit into one of these system types. If the system does not fit into one of these categories, select the system type that most closely describes the New System.

<u>System Type</u>	<u>Generic Missions</u>
AIR DEFENSE WEAPONS including: Short Range Missiles, Medium Range Missiles, Long Range Missiles, Air Defense Guns, High Energy Systems	<ol style="list-style-type: none"> 1. Destroy enemy aircraft. 2. Confuse and delay enemy aircraft. 3. Deny selected airspace/formation to attacking aircraft. 4. Destroy enemy ground targets.
ARMORED VEHICLES including: Main Battle Tanks, Armored Reconnaissance Vehicles/Light Tanks, Infantry/Cavalry Fighting Vehicles, Armored Personnel Carriers Mounting Anti-Tank Weapons	<ol style="list-style-type: none"> 1. Destroy enemy fixed emplacements. 2. Destroy enemy armored vehicles. 3. Destroy enemy troops. 4. Destroy/disrupt enemy aircraft. 5. Delay/suppress enemy activity. 6. Escort/screen friendly forces. 7. Transport combat troops. 8. Perform reconnaissance. 9. Seize and occupy terrain.
AVIATION SYSTEMS including: Attack Helicopters, Scout Helicopters, Transport Helicopters, Utility Helicopters, Fixed-Wing Reconnaissance, Fixed-Wing Transport	<ol style="list-style-type: none"> 1. Destroy enemy armored vehicles. 2. Destroy enemy helicopters. 3. Destroy enemy fixed emplacements. 4. Destroy enemy troops. 5. Delay/suppress enemy activity. 6. Perform reconnaissance. 7. Escort/screen friendly forces. 8. Transport combat troops. 9. Transport logistical supplies. 10. Evacuate casualties
BATTLEFIELD COMMUNICATION SYSTEMS including: Man-Portable Radios, Vehicle-Portable Radios, Visual Communications Systems, Base Radio Systems	<ol style="list-style-type: none"> 1. Transfer information and orders between concerned units/individuals.

¹ The system missions in this table were extracted from "A Concept for Developing Human Performance Specifications." Jonathan D. Kaplan and William H. Crooks. Technical Memorandum 7-80, U.S. Army Human Engineering Laboratory. April 1980.

Table 1.1-1. System-Type Missions (Continued)

<u>System Type</u>	<u>Generic Missions</u>
C ² /C ¹ SYSTEMS including: Field Artillery Fire Control, Tank Fire Control, Air Defense Fire Control	<ol style="list-style-type: none"> 1. Provide information on current battle-field conditions and situation. 2. Provide projections of probable future conditions and enemy behavior. 3. Control the behavior of friendly forces. 4. Manage friendly weapon operation. 5. Manage logistics. 6. Communicate information to appropriate units.
COMBAT/TACTICAL SUPPORT EQUIPMENT including: Combat Engineer Vehicles, Recovery Vehicles, Demolition Equipment, Bridging Equipment	<ol style="list-style-type: none"> 1. Destroy/remove obstacles/roadblocks. 2. Construct obstacles/roadblocks. 3. Bridge obstacles. 4. Construct emplacements/shelters. 5. Transport command posts. 6. Transport damaged vehicles. 7. Destroy enemy armored vehicles/personnel.
ELECTRONIC WARFARE AND SURVEILLANCE SYSTEMS including: Countermeasures Equipment, Sighting and Surveillance Equipment	<ol style="list-style-type: none"> 1. Provide critical information on potential targets. 2. Confuse/disrupt/disable enemy systems. 3. Jam electronic signals. 4. Produce false targets/target signatures.
GROUND TRANSPORTATION EQUIPMENT including: 1/4 Ton Utility Trucks, 3/4 to 1-1/2 Ton Trucks, 8 to 10 Ton Trucks, Heavy Equipment Transport Trucks	<ol style="list-style-type: none"> 1. Transport command personnel. 2. Transport troops. 3. Transport materiel. 4. Serve as an ambulance.
INFANTRY WEAPONS including: Pistols/Revolvers, Rifles, Sub-Machine Guns, Machine Guns, Recoil-less Rifles, Anti-Tank Missile Systems, Anti-Aircraft Missile Systems, Grenades, Grenade Launchers, Anti-Armor Mines/Anti-Personnel Mines, Flamethrowers, Mortars	<ol style="list-style-type: none"> 1. Destroy enemy vehicles. 2. Destroy low flying enemy aircraft. 3. Destroy enemy fixed emplacements. 4. Destroy enemy troops. 5. Delay/suppress enemy activity. 6. Provide illumination. 7. Conceal friendly forces by making smoke.

Table 1.1-1. System-Type Missions (Continued)

<u>System Type</u>	<u>Generic Missions</u>
TARGET ACQUISITION AND/OR DESIGNATOR SYSTEMS	<ol style="list-style-type: none"> 1. Provide critical information on potential targets. 2. Designate/illuminate target.
ORDNANCE SYSTEMS including: Light, Towed, Tube Artillery; Light, Self-propelled, Tube Artillery; Medium, Towed, Tube Artillery; Medium, Self-propelled, Tube Artillery; Heavy, Towed Tube Artillery; Battlefield Support Guided Missiles; Battlefield Support Unguided Missiles; Multiple Launch Guided Missiles; Multiple Launch Unguided Missiles	<ol style="list-style-type: none"> 1. Destroy enemy fixed emplacements on or behind the battlefield. 2. Destroy enemy vehicle's weapons. 3. Destroy enemy personnel. 4. Delay/suppress enemy activity. 5. Provide illumination. 6. Conceal friendly forces by making smoke.

-
- For any additional mission not listed in Table 1.1-1, ask the following questions to determine whether the mission is stated correctly:²
 - Is this mission one ultimate purpose of the system, rather than a number of ultimate purposes collapsed together?
 - Is this a mission that can be performed successfully by an individual system, or must it be performed by several systems?
 - Is the performance of this mission measurable directly and understandably?
 - Rewrite the mission if the answer to any of these questions is "No."
 - Record the New System's missions on Worksheet 1.1-1.

² These questions were extracted from "A Concept for Developing Human Performance Specifications," Jonathan D. Kaplan and William H. Crooks, Technical Memorandum 7-80, U.S. Army Human Engineering Laboratory, April 1980.

Procedure 1 and 2 Examples

The analyst obtains the New System documents and determines that the New System is a self-propelled, medium-range, ground missile launcher. This missile launcher belongs to the "Ordnance Systems" system type.

Procedure 3 Example

Six generic missions can apply to Ordnance Systems; however, only three missions apply to the New System:

1. Destroy Enemy Fixed Emplacements.
2. Destroy Enemy Vehicle's Weapons.
3. Delay/Suppress Enemy Activity.

The analyst may think that another mission, Provide Control of Surrounding Territory, is required. However, the answers to the questions in Procedure 2 are:

1. This mission is a condensed statement of several missions.
 - a. Destroy enemy fixed emplacements.
 - b. Destroy enemy vehicle's weapons.
 - c. Destroy enemy troops.
 - d. Delay/suppress enemy activity.
 - e. Etc.
 2. The Provide Control of Surrounding Territory mission cannot be performed successfully by a single system.
 3. The Provide Control of Surrounding Territory mission cannot be measured directly. Its measurement depends on other systems' ability to perform their intended missions.
-

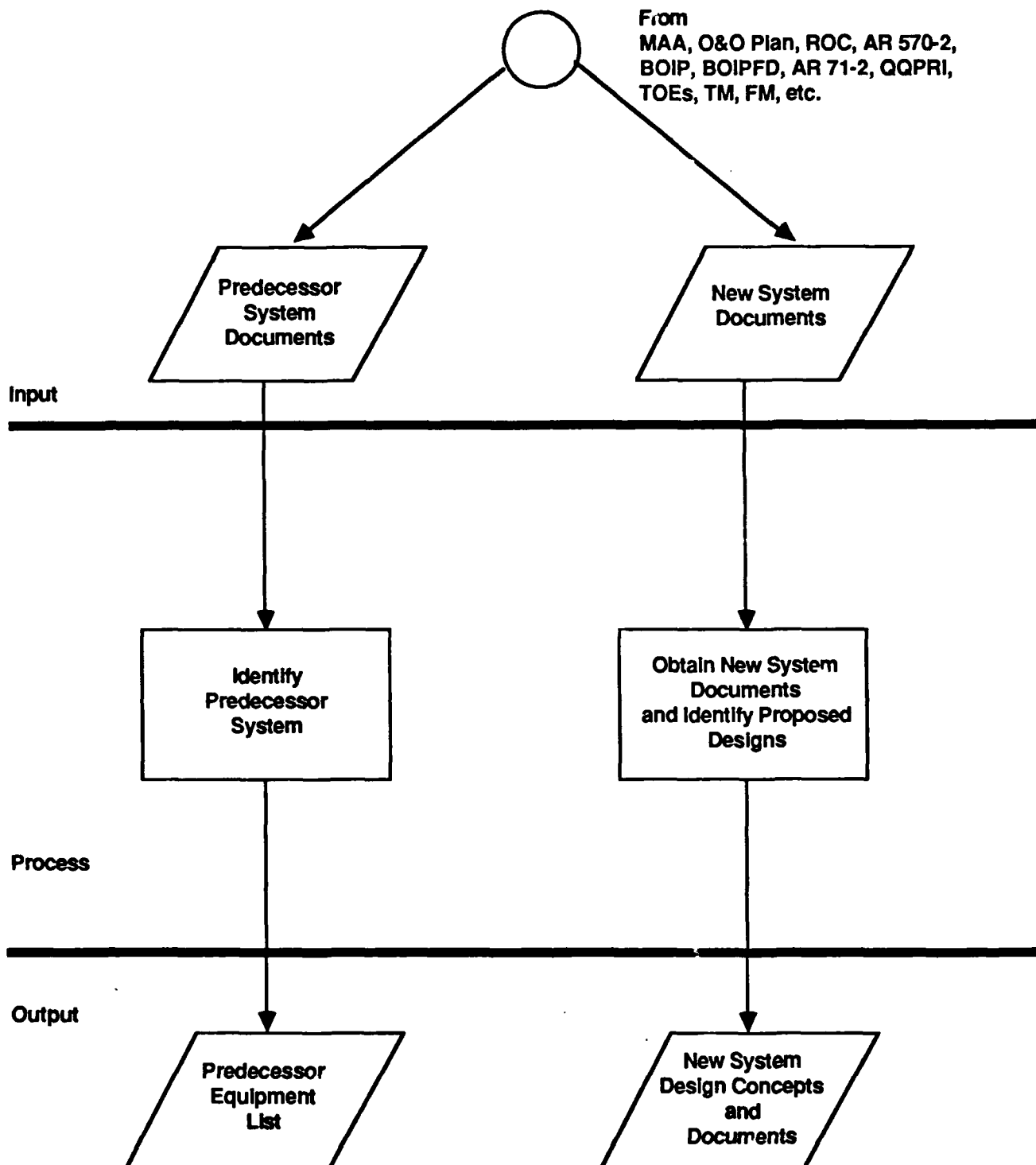


Figure 1.2-1. Overview of Substep 1.2, Identify the Predecessor System and the New System Concepts.

Action Step 1: Identify the Predecessor System

Discussion

The analyst uses the procedures in this action step to identify the Predecessor System. The Predecessor System is the fielded Army system currently performing the functions required of the New System.

Occasionally, a New System will replace more than one existing system. In this case each existing system is considered a Predecessor System. The New System's MPT requirements must be compared with each existing system under the specific organizational context of that existing system.

The task of identifying the Predecessor System varies in difficulty depending on the size of the system. Major end-item Predecessor Systems are easier to identify than Predecessor Systems that are collections of systems, subsystems, or components integrated only by their operational functions.

Procedures

1. Obtain Predecessor System/Component Documents.
 - Obtain the Tables of Organization and Equipment (TOEs) and AR 570-2, *Manpower Requirements Criteria (MARC)* — *Tables of Organization and Equipment*.
2. Determine the Predecessor System.
 - Determine whether the New System is replacing a single major end-item system or a combination of systems and/or subsystems. If a major end-item is to be replaced, skip to Procedure 3. If a combination of systems and/or subsystems is to be replaced, continue with this procedure.
 - Review the New System's Basis of Issue Plan (BOIP) for Predecessor System equipment (listed by Line Item Number [LIN]) to be replaced by the New System's equipment.
 - Review the TOEs and identify organizations to which the Predecessor System is fielded. For each LIN identified in the BOIP, record on Worksheet 1.2-1 the equipment quantities by LIN, by organizational element, and by Predecessor configuration.

-
- Determine whether the LINs identified in the BOIP meet the New System's functional requirements. If they do not, review the TOEs again to identify the remaining functionally driven equipment. When documenting the Predecessor System, indicate the source of the equipment.

NOTE

The analyst should make an effort to identify LINs for each piece of equipment. The manpower analyst may use these LINs in Step 2 to extract Predecessor System workload from the MARC data base.

3. Develop a Predecessor System Equipment List by LIN.

- Review Predecessor System documents and develop a Predecessor System equipment list. Develop this list by LIN so it will be easier to determine Predecessor System requirements in subsequent procedures.
- Record the Predecessor System equipment list on Worksheet 1.2-2.

Procedure 1 and 3 Examples

The APACHE is a quick reaction, mobile anti-tank, anti-armor weapon capable of all-weather, 24-hour mission performance. The APACHE is a single rotor, twin engine, attack helicopter armed with up to 16 Hellfire missiles, 76 2.75-inch rockets or some combination thereof, and a 30-millimeter chain gun. The system will be operated by a pilot and copilot/gunner. The Predecessor System for the APACHE is the AH-1S. The avionics equipment and corresponding LINs for the AH-1S are as follows:

<u>Line Item Number</u>	<u>Equipment Name</u>
Q25990	FM radio system AN/ARC 114A FM receiver-transmitter Filter FM communication antenna FM homing antenna Mounting Intercommunications sys C-6533 ()/ARC Interphone control Headset
Q25992	UHF radio system AN/ARC-116 UHF receiver-transmitter Air cooler Mounting UHF & VHF antenna system Antenna
X22540	Transponder system AN/APX 44 Receiver-transmitter Control Antenna Mounting
J99737	Gyrosyn compass AN/ASN-43 Directional gyro, electronically driven Remote-transmitter Error compensator, single cycle Controller compass set
X22568	Transponder system AN/APX 72 Receiver-transmitter Control Antenna Mounting

(continued)

Procedure 1 and 3 Examples (continued)

<u>Line Item Number</u>	<u>Equipment Name</u>
G11703	Direction finder set AN/ARN 89A Receiver Antenna Control Impedance matching amplifier
Q25991	VHF radio system AN/ARC 115 VHF transceiver Transponder test set VOR/LOC/GS/MB sys Receiver-transmitter Control Mount Antenna. marker beacon Antenna. VOR/LOC Antenna. glidescope Mounting equipment rack Emergency locator transmitter

Procedure 1, 2, and 3 Examples

In this example the Predecessor System is not an easily identified, integrated set of equipment and subsystems; rather, it is a collection of equipment, systems, and soldiers. The Predecessor System's configuration varies depending on the operational organization. The Predecessor System's TOEs and the New System's BOIP (feeder data only) are available. The BOIP feeder data (BOIPFD) identifies the Predecessor System communication equipment that will be replaced by the New System.

The analyst examines the New System's BOIPFD. BOIPFD Block 12 (Item to be Replaced/Associated Support) identifies equipment to be replaced:

BLOCK 12. Items to be replaced/associated support.

<u>LINE ITEM NUMBER</u>	<u>NOMENCLATURE</u>	<u>COMPLETE OR IN PART</u>	<u>RECOMMENDED TC/RTC</u>
N20115	OPS Center Comms: AN/ MSC-31 less power	Partial	STD-A
A23907	Air Conditioner Flr Mtg A/ CAC 115V 1 PH 60 CY 9000 BTU	Partial	STD-A
J47480	Gen St Gas Eng TM: 5KW 60 CY 1-3 PH AC 120/240 120/208V PU- 618/M	Partial	STD-A
T61494	Trk Util: Cgo/Troop Carrier 5/4 Ton 4x4 w/e (HMMWV)	Partial	STD-A
A23701	Air Conditioner: FL/ WNDW A/C .115V 1 PH 60 CY 6000 BTU	Partial	STD-A
Q90100	RDO TTY Set: AN/GRC- 122	Partial	STD-A
T59414	Trk Cgo: Tac 5/4 ton 4x4 Shelter Carrier w/e M1028	Partial	STD-A
J47617	Gen St Gas Eng TM: 5 KW 60 HZ 2 ea MTD on M116 PU- 620	Partial	STD-A

(continued)

Procedure 1, 2, and 3 Examples (continued)

<u>LINE ITEM NUMBER</u>	<u>NOMENCLATURE</u>	<u>COMPLETE OR IN PART</u>	<u>RECOMMENDED TC/RTC</u>
T07543	Trk Util: S250 Shelter Carrier 4x4 w/e (HMMWV)	Partial	STD-A
V57504	Terminal Telegraph: AN/ TSC-58 Less Power	Partial	STD-A
D77780	Data Analysis Central: AN/TYQ- 5/V/4	Partial	STD-A
J42100	Gen ST Gas Eng TM: 10 KW 60 HZ 1-3 PH AC 120/240 120/208V PU- 619/M	Partial	STD-A
X39453	Trk Cgo: Tac 5/4 ton 4x4 w/100 AMP-Comm Shelter Kt/we	Partial	STD-A
C60572	Communications Terminal AN/TSC- 87	Partial	STD-A
V36146	Communications Terminal AN/VGC- 74A(V)3	Partial	STD-A
X40009	Trk Cgo: 2-1/2 ton 6x6 w/e	Partial	STD-A
X62237	Trk Van, Expansible 5 ton 6x6	Partial	STD-A
X40077	Trk Cgo: Dropside 2-1/2 ton 6x6 w/e	Partial	STD-A

The analyst then reviews the TOEs and identifies organizations to which the Predecessor System is fielded. He or she records the equipment quantities by LIN, by organizational element, and by Predecessor configuration:

(continued)

Procedure 1, 2, and 3 Examples (continued)**Heavy Division - TOE 3286J600**

<u>LIN (From BOIP)</u>	<u>Quantity</u>
OPERATIONS SECTION	
A24455	2
C60572	1
P27819	1
S01373	6
V98788	6
X40009	2
X40077	2
TFC ANAL TEAM	
A24455	1
P27819	1
X40077	1

The Predecessor System, as identified by the BOIPFD, appears to be incomplete. The communications functions performed by the New System will likely displace certain existing equipment. The analyst reviews the TOEs and identifies the remaining functionally driven equipment. He or she then adds this equipment to the equipment specified in the BOIP:

Heavy Division - TOE 3286J600

<u>LIN</u>	<u>BOIP-IDENTIFIED</u>	<u>ANALYST-IDENTIFIED</u>	<u>QUANTITY</u>
OPERATIONS SECTION			
A24455	X		2
A79381		X	5
C60572	X		1
E98103		X	5
K87328		X	4
K87564		X	4
N02758		X	5
P27819	X		1
R31541		X	1

(continued)

Procedure 1, 2, and 3 Examples (continued)

<u>LIN</u>	<u>BOIP- IDENTIFIED</u>	<u>ANALYST- IDENTIFIED</u>	<u>QUANTITY</u>
R45203		X	4
S01373	X		6
T25726		X	1
T40405		X	5
U81707		X	1
V98788	X		6
W60357		X	1
X40009	X		2
X40077	X		2
TFC ANAL TEAM			
A24455	X		1
P27819	X		1
X40077	X		1

The analyst then reviews Predecessor System documents and develops a Predecessor System equipment list by LIN and organizational element. (The equipment list shown below represents only the first few pieces of equipment in the list.)

<u>LIN</u>	<u>Equipment Name</u>	<u>Heavy Division</u>	<u>Light Division</u>	<u>Heavy Corps</u>	<u>Light Corps</u>	<u>Echelon Above Corps</u>
A24455	Air Conditioner: Flr Mtg A/C 208 3PH 60 CY 18,000 BTU CMP VRT	5	2	10	10	5
A24763	Air Conditioner: Fl/Wall A/C 280V 50-60 CY 3PH 36,000 BTU CMP HZ	3	-	6	6	3
A72260	Antenna: RC-292	-	3	-	-	-
A79381	Antenna Group: OE-254 (I)/GRC	7	3	-	-	7
C60572	Communications Terminal AN/TSC-87	1	1	1	1	1

(continued)

Procedure 1, 2, and 3 Examples (continued)

<u>LIN</u>	<u>Equipment Name</u>	<u>Heavy Division</u>	<u>Light Division</u>	<u>Heavy Corps</u>	<u>Light Corps</u>	<u>Echelon Above Corps</u>
D77692	Data Analysis Central: AN/TKY-10A	1	1	-	-	1
D77712	Data Analysis Central: AN/TYQ-5/V/3	2	1	6	6	2
D77780	Data Analysis Central: AN/TYQ-5/V/4	3	3	4	4	3
E01727	Electronic Counter Counter-measure (ECCM) Unit: C- 11290()/VRC	6	-	-	-	6
E03096	Elect Processing and Dissemination SYS: AN/TSQ-134(V)1	-	-	1	1	-
E98103	Elec Transfer Keying Device ETKD: KYK-13/ TSEC	8	2	-	-	8
H02300	Electronic Teletype- writer Security Equipment: TSEC/KW- 7	-	-	2	2	-
J35492	Gen St Dsl Eng TM: 15 KW 60 HZ MTD MTD M M-200 AI PU-405	-	-	5	5	-

Action Step 2: Obtain New System Documents and Identify Design Concepts

Discussion

In this action step the analyst obtains available New System documents. Collecting New System documents is a continual process that each member of the HCM analysis team contributes to during an analysis.

The analyst uses the New System documents to identify proposed designs. These designs may have been developed by the Army or by prime contractors. The analyst must be in constant contact with New System subject-matter experts (SMEs) because the design concepts may change during the analysis. (The analyst will update the design concepts in Substeps 1.3, 1.6, and 1.7.)

Procedures

1. **Obtain the New System Documents.**
 - Obtain the following documents:
 - Mission Area Analysis (MAA) (when available);
 - Operational and Organizational (O&O) Plan;
 - Required Operational Capability (ROC);
 - Basis of Issue Plans (BOIPs) or BOIP Feeder Data (BOIPFD);
 - Qualitative and Quantitative Personnel Requirements Information (QQPRI);
 - Integrated Logistics Support Plan (ILSP); and
 - contractor documentation/proposals.
2. **Obtain the Proposed Designs.**
 - Use the New System documents to identify proposed designs.
 - Keep all New System information in an audit trail that is accessible to the HCM analysis team.

Procedure 1 & 2 Examples

The New System is a lightweight assault gun. The analyst collects and reviews New System documents and determines that several of the New System's requirements can be met by actual proposed subsystems and components.

One of the New System's requirements is a thermal driver's sight. The Program Manager's (PM) office and some of the system documents have indicated that the thermal driver's sight from the M1 tank will be used in the New System.

The New System also requires a transmission system. The analyst determines that three transmissions are being considered. These transmissions are the XM88 from the WAG Corporation, TR4 from the XYZ Corporation, and the existing M1 transmission. The analyst collects information for the WAG, XYZ, and M1 transmissions.

**SUBSTEP 1.2
WORKSHEETS**

WORKSHEET 1.2-1

Use this worksheet to document multiple Predecessor Systems.

LIN	Equipment Quantity	Organizational Elements	Predecessor Configuration	Source

WORKSHEET 1.2-2.

Use this worksheet to develop the Predecessor System equipment list.

Predecessor System: _____

Line Item Number	Nomenclature

Substep 1.3: Conduct New System Functional Analysis

Overview

In this substep the analyst develops system functions and associated functional requirements. System functions, both operational and non-operational, are actions that must be performed to accomplish a system mission. Functions can be performed by the entire system (high-level functions), by subsystems (low-level functions), or by other accompanying systems. Figure 1.3-1 is an overview of this substep.

Operational functions can be determined by system type or, when applicable, can be developed from system missions. Non-operational functions depend more on the system itself and its perceived operational doctrine. The analyst allocates system functions to respective system entities, i.e., hardware, software, and humans.

In addition to developing functions, the analyst determines functional requirements in this substep. A functional requirement is an inherent characteristic that allows the New System to perform the required function within the environmental conditions and performance requirements. Table 1.3-1 shows how missions, functions, subfunctions, and functional requirements differ.

The analyst will use the following information to complete this substep: Predecessor System and New System information (Substep 1.2); Mission Area Analysis (MAA) studies; the Justification for Major System New Start (JMSNS); the Required Operational Capability (ROC); and the Operational and Organizational (O&O) Plan.

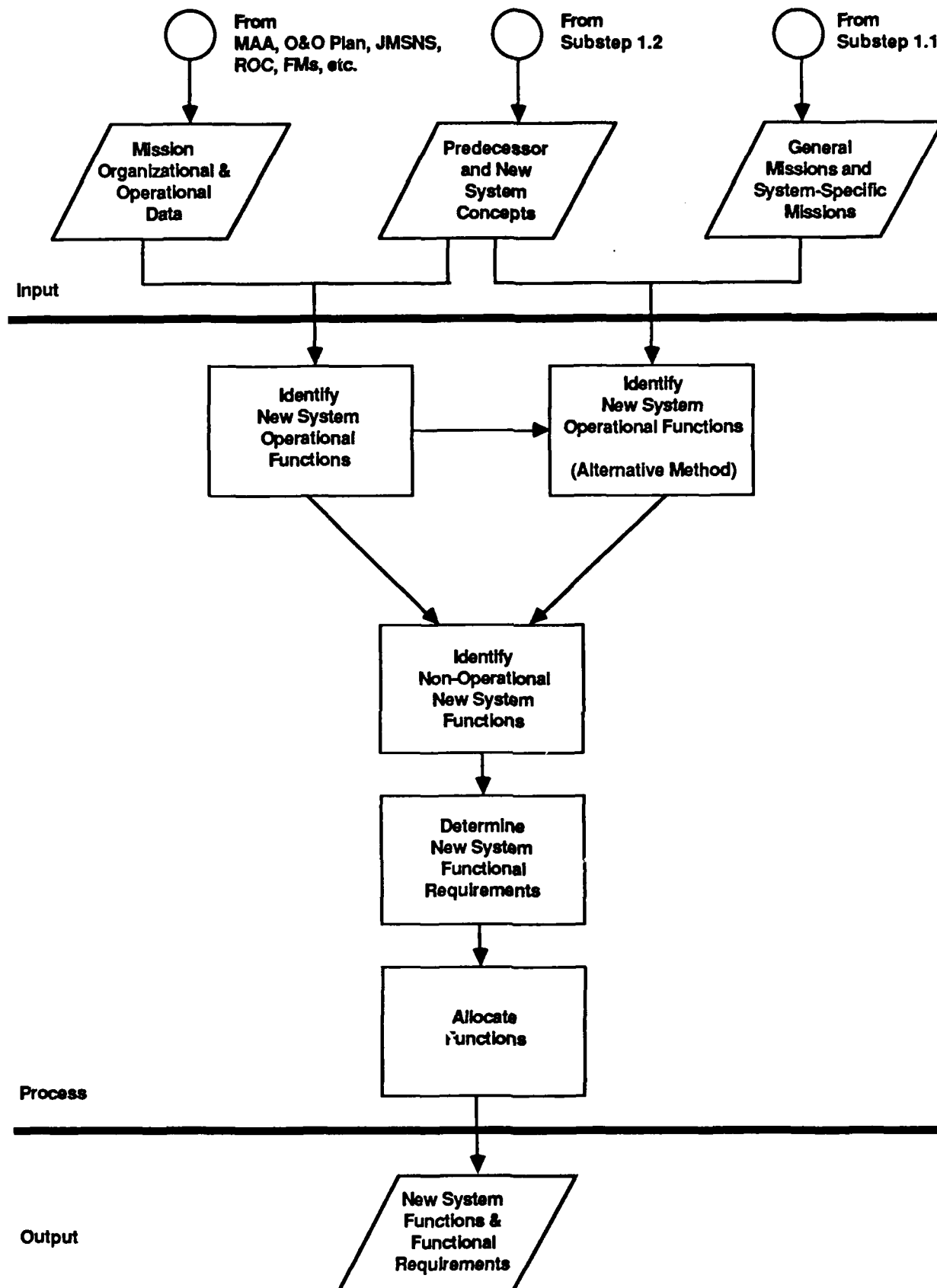


Figure 1.3-1. Overview of Substep 1.3, Conduct New System Functional Analysis.

Table 1.3-1. Differences Among Missions, Functions, Subfunctions, and Functional Requirements

		<u>Applies to:</u>
Mission	Actions to be accomplished by a command	Forces/units/multiple systems/ single systems
Function	Actions required to perform a mission	System (interaction of all system elements)
Subfunction	Actions required to perform a function	Subsystem/components (inter- action of particular system elements)
Functional Requirements	Attributes or capabilities required to perform a function/ subfunction	Functions and subfunctions

Action Step 1: Identify New System Operational Functions

Discussion

In this action step the analyst identifies the New System's required operational functions. The analyst obtains high-level functions and breaks these functions down into subfunctions. He or she uses the lists of operational functions in Appendix A throughout this process. The operational functions in these lists are categorized by system type.

Procedures

1. Refer to the Operational-Functions List.

- Refer to the Appendix A directory on page A-1 and locate the appropriate list of operational functions for the New System.

NOTE

The New System may not readily fit into any of the categories in Appendix A. In such cases the analyst should use the alternative method for this action step. (See the next action step.)

2. Develop High-Level New System Operational Functions.

- Identify the relevant high-level functions in the operational-functions list. The functions listed for each system type may not include all required system functions or may provide functions that are not relevant to the New System. Add to or subtract from these lists to obtain an appropriate set of New System functions.

3. Develop New System Operational Subfunctions.

- Return to the operational-functions list and identify subfunctions. Add unlisted subfunctions and delete irrelevant subfunctions. (The analyst is not limited to the subfunction level of indenture in the function lists in Appendix A.) Work toward a level of detail that will suit the development of the generic equipment list in Substep 1.4 and operator/maintainer task lists in Substep 1.8.
- On Worksheet 1.3-1 record the high-level functions and associated subfunctions identified in Procedure 2.

Procedure 1 Example

The analyst locates the functions for a self-propelled, medium-range, ground missile launcher in Appendix A.

Procedure 2 and 3 Examples

The analyst refers to Appendix A to determine the following high-level functions and lower-level subfunctions for the self-propelled, medium-range, ground missile launcher:

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Prepare for March Order	Receive March Order Receive Weapon from Assembly and Transport Section Perform Pre-Operational Preventive Maintenance Checks & Services (PMCS) Survey Firing Point
Move to Firing Point	Start Engine Drive Self-propelled Launcher (SPL)
Navigate	Identify Present Location Identify Destination Select Travel Route Negotiate Selected Route, Monitor Current Location
Communicate	Transmit/Receive Messages Encode/Decode Messages Communicate Using Countermeasures Procedures Use Vehicle Intercom for Crew Communications
Emplace System	Position SPL Over Launch Stake Shut Down Vehicle Prepare Vehicle for Firing Mode

(continued)

Procedure 2 and 3 Examples (continued)

High-Level Functions

Lower-Level Subfunctions

Prepare Weapon for Firing

Inspect Main Missile Assembly
(MMA) and Warhead Section
(WHS) for Damage
Release Tie Down Straps,
Traverse, and Lockpins

Fire Weapon

Receive Firing Data
Turn on Monitor-Programmer
Conduct Self-test
Determine Evaluation & Azimuth
Lay Weapon
Remove Protective Covers

Conduct Post-Firing
Inspections

Arm WHS
Insert WHS Settings
Move Firing Device to Firing Pit
Elevate Missile
Place Selector in Launch Position
Clear Area
Fire Missile

Execute Failure-to-
Fire Procedures

Lower Launcher
Safe the WHS
Disconnect Firing Device
Perform Failure-to-Fire
Troubleshooting Procedures
Reconnect Firing Device
Obtain New Orientation from
Remote Theodolite
Reorient Launcher

Perform Emergency
Destruction of Warhead

Insert Command Disablement Code
Set Shape Charge to Warhead
Evacuate Area
Destroy Warhead
Verify Destruction

Displace System

Secure Launcher
Leave Position

Action Step 1 (Alternative Method): Identify New System Operational Functions

Discussion

The analyst uses this action step as an alternative approach to developing New System operational functions.

A finite set of generic functions applies to all systems. From this generic set the analyst must identify the specific functions that apply to the New System. The analyst must also divide general, high-level functions into progressively more detailed subfunctions. By dividing the functions into subfunctions, the analyst will be better able to choose generic equipment in Substep 1.4 and to determine operator/maintainer tasks in Substep 1.8.

Procedures

1. **Develop High-Level New System Operational Functions.**
 - Examine Table 1.3-2, which provides a list of generic operational functions and subfunctions. From this table, select the high-level functions needed to perform each mission.
 - Review Appendix A for additional high-level functions that may be relevant to the New System. Refer to operational-function lists for the system types that are most similar to the New System.

NOTE

The analyst may need to expand individual high-level functions in Table 1.3-2; for example, the New System's primary function is to shoot or fire multiple rounds of various types of ammunition. Other functions listed do not apply; therefore, suggested subfunctions of the function Shoot may become high-level functions.

Table 1.3-2. Generic Operational Functions

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Mission Management	Plan Mission Prepare System Control Mission Execute Mission Evaluate Mission Operate Mission Equipment Perform Post-Mission Actions
Move	Displace/Emplace System Navigate System Fly System Drive System
Shoot	Acquire Target Attack Target Perform Post-Firing Procedures
Communicate	Transmit Messages Receive Messages Encode/Decode Messages Interpret Messages Process Messages
Perform Command and Control Actions	Sense Data/Information Collect Data/Information Process Data/Information Analyze Data/Information Manage Data/Information Decide on Action to Be Taken Take Action Disseminate Action
Perform Intelligence Actions	Perform Reconnaissance Seek Data/Information Sense Data/Information Detect Data/Information Process Data/Information Identify Data/Information Analyze Data/Information Track Data/Information Disseminate Action

2. Develop New System Operational Subfunctions.

- Return to Table 1.3-2 and the operational-function lists in Appendix A and identify applicable subfunctions. Add unlisted subfunctions and delete irrelevant subfunctions. (The analyst is not limited to the subfunction level of indenture indicated in Table 1.3-2 or the function lists in Appendix A.) Work toward a level of detail that will best suit the development of the generic equipment list in Substep 1.4 and operator/maintainer task lists in Substep 1.8.
- Record the high-level functions and their associated subfunctions on Worksheet 1.3-1.

Procedure 1 and 2 Examples

The All Source Analysis System (ASAS) is under development as part of a joint effort between the Army and Air Force to field a common and comprehensive Intelligence and Electronic Warfare (IEW) system. The system embodies the concept of tactical fusion, which involves combining information and reports from many sources and sensors and fusing them into a coherent, accurate system that delineates what is happening on a battlefield. Tactical fusion uses computers to assist in the correlation and display of intelligence in support of command decision making in combat operations.

The ASAS's required operational functions and corresponding subfunctions are:

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Mission Management	Plan Mission Accomplishment Evaluate Mission Performance Control Mission Performance Operate System
Communicate	Receive Messages Transmit Messages Perform Communication Processing Perform Communication Housekeeping
Perform Command and Control Actions	Perform Initial Information Processing (IIP) Perform Single Source Analysis (SSA) Perform All Source Processing (ASP) Perform Situation Development Perform Target Development Perform EW Support Provide OPSEC Support Display Information Draft Intelligence & Support Messages Manage Data

Action Step 2: Identify Non-Operational New System Functions

Discussion

The analyst identified system operational functions in Action Step 1. In this action step he or she determines non-operational system functions, for example, protect system, maintain system, supply system, and transport system. These functions can be accomplished by the system alone, by a combination of the system and some other system, or by another system. The analyst should be sure to include only those functions and systems within the analysis scope.

In some instances high-level non-operational functions may be at a sufficient level of detail for the analyst to derive generic equipment and tasks. The analyst should develop subfunctions only when high-level functions are not sufficiently detailed.

Procedures

1. **Identify New System Protective Functions.**
 - Determine high-level system protective functions for each mission by adding to or subtracting from the list of protective functions in Table 1.3-3.
 - Record the high-level protective functions on Worksheet 1.3-1.
 - Develop lower-level subfunctions, if necessary.
 - Record these subfunctions on Worksheet 1.3-1.
2. **Identify New System Maintenance Functions.**
 - Determine high-level system maintenance functions for each mission by adding to or subtracting from the list of maintenance functions in Table 1.3-3.
 - Record the high-level maintenance functions on Worksheet 1.3-1.
 - Develop lower-level subfunctions for each high-level maintenance function, if necessary.
 - Record these subfunctions on Worksheet 1.3-1.

3. Identify New System Supply Functions.

- Determine high-level system supply functions for each mission by adding to or subtracting from the list of supply functions in Table 1.3-3.
- Record the high-level supply functions on Worksheet 1.3-1.
- Develop lower-level subfunctions, if necessary.
- Record these subfunctions on Worksheet 1.3-1.

4. Identify New System Transport Functions.

- Determine high-level system transport functions for each mission by adding to or subtracting from the list of transport functions in Table 1.3-3.
- Record the high-level transport functions on Worksheet 1.3-1.
- Develop lower-level subfunctions, if necessary.
- Record these subfunctions on Worksheet 1.3-1.

Table 1.3-3. High-Level Non-Operational Functions

<u>Function Type</u>	<u>High-Level Functions</u>
Protective Functions	Provide Ballistic/Kinetic Protection Provide Chemical/Biological Protection Provide Nuclear/Electromagnetical Protection Provide Protection from Adverse Climates Avoid Detection
Maintenance Functions	Perform Corrective Maintenance Perform Preventive Maintenance Install Mission-Specific Equipment Repair Battle Damage Replenish System (Load System) Upgrade System Decontaminate System
Supply Functions	Supply Parts Supply Ammunition Supply Fuel Supply Power
Transport Functions	Prepare System for Transport Transport System

Procedure 1-4 Examples

The analyst determines the high-level non-operational functions for the All Source Analysis System (ASAS):

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Protective Functions	Provide Ballistic/Kinetic Protection Provide Chemical/Biological Protection Provide Nuclear/Electromagnetical Protection Provide Transportation Damage Protection
Maintenance Functions	Perform Corrective Maintenance Perform Preventive Maintenance Install Mission-Specific Equipment Upgrade System Decontaminate System
Supply Functions	Supply Parts Supply Power Supply Environmentally Required Equipment
Transport Functions	Prepare System for Transport Transport System

Substep 1.3: Conduct New System Functional Analysis

Overview

In this substep the analyst develops system functions and associated functional requirements. System functions, both operational and non-operational, are actions that must be performed to accomplish a system mission. Functions can be performed by the entire system (high-level functions), by subsystems (low-level functions), or by other accompanying systems. Figure 1.3-1 is an overview of this substep.

Operational functions can be determined by system type or, when applicable, can be developed from system missions. Non-operational functions depend more on the system itself and its perceived operational doctrine. The analyst allocates system functions to respective system entities, i.e., hardware, software, and humans.

In addition to developing functions, the analyst determines functional requirements in this substep. A functional requirement is an inherent characteristic that allows the New System to perform the required function within the environmental conditions and performance requirements. Table 1.3-1 shows how missions, functions, subfunctions, and functional requirements differ.

The analyst will use the following information to complete this substep: Predecessor System and New System information (Substep 1.2); Mission Area Analysis (MAA) studies; the Justification for Major System New Start (JMSNS); the Required Operational Capability (ROC); and the Operational and Organizational (O&O) Plan.

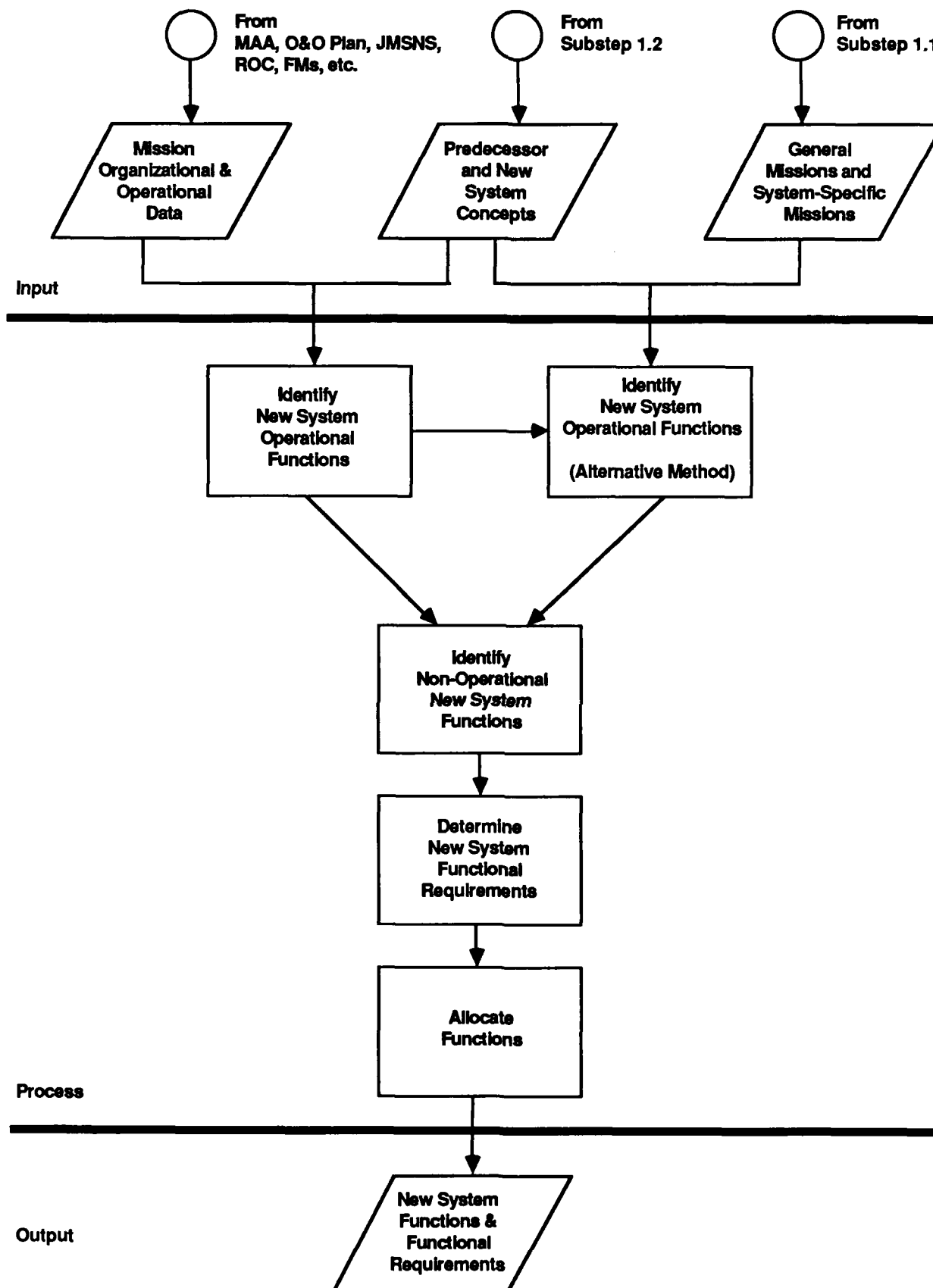


Figure 1.3-1. Overview of Substep 1.3, Conduct New System Functional Analysis.

Table 1.3-1. Differences Among Missions, Functions, Subfunctions, and Functional Requirements

		<u>Applies to:</u>
Mission	Actions to be accomplished by a command	Forces/units/multiple systems/ single systems
Function	Actions required to perform a mission	System (interaction of all system elements)
Subfunction	Actions required to perform a function	Subsystem/components (inter- action of particular system elements)
Functional Requirements	Attributes or capabilities required to perform a function/ subfunction	Functions and subfunctions

Action Step 1: Identify New System Operational Functions

Discussion

In this action step the analyst identifies the New System's required operational functions. The analyst obtains high-level functions and breaks these functions down into subfunctions. He or she uses the lists of operational functions in Appendix A throughout this process. The operational functions in these lists are categorized by system type.

Procedures

1. **Refer to the Operational-Functions List.**

- Refer to the Appendix A directory on page A-1 and locate the appropriate list of operational functions for the New System.

NOTE

The New System may not readily fit into any of the categories in Appendix A. In such cases the analyst should use the alternative method for this action step. (See the next action step.)

2. **Develop High-Level New System Operational Functions.**

- Identify the relevant high-level functions in the operational-functions list. The functions listed for each system type may not include all required system functions or may provide functions that are not relevant to the New System. Add to or subtract from these lists to obtain an appropriate set of New System functions.

3. **Develop New System Operational Subfunctions.**

- Return to the operational-functions list and identify subfunctions. Add unlisted subfunctions and delete irrelevant subfunctions. (The analyst is not limited to the subfunction level of indenture in the function lists in Appendix A.) Work toward a level of detail that will suit the development of the generic equipment list in Substep 1.4 and operator/maintainer task lists in Substep 1.8.
- On Worksheet 1.3-1 record the high-level functions and associated subfunctions identified in Procedure 2.

Procedure 1 Example

The analyst locates the functions for a self-propelled, medium-range, ground missile launcher in Appendix A.

Procedure 2 and 3 Examples

The analyst refers to Appendix A to determine the following high-level functions and lower-level subfunctions for the self-propelled, medium-range, ground missile launcher:

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Prepare for March Order	Receive March Order Receive Weapon from Assembly and Transport Section Perform Pre-Operational Preventive Maintenance Checks & Services (PMCS) Survey Firing Point
Move to Firing Point	Start Engine Drive Self-propelled Launcher (SPL)
Navigate	Identify Present Location Identify Destination Select Travel Route Negotiate Selected Route, Monitor Current Location
Communicate	Transmit/Receive Messages Encode/Decode Messages Communicate Using Countermeasures Procedures Use Vehicle Intercom for Crew Communications
Emplace System	Position SPL Over Launch Stake Shut Down Vehicle Prepare Vehicle for Firing Mode

(continued)

Procedure 2 and 3 Examples (continued)

High-Level Functions

Lower-Level Subfunctions

Prepare Weapon for Firing

Inspect Main Missile Assembly
(MMA) and Warhead Section
(WHS) for Damage
Release Tie Down Straps,
Traverse, and Lockpins

Fire Weapon

Receive Firing Data
Turn on Monitor-Programmer
Conduct Self-test
Determine Evaluation & Azimuth
Lay Weapon
Remove Protective Covers

Arm WHS
Insert WHS Settings
Move Firing Device to Firing Pit
Elevate Missile
Place Selector in Launch Position
Clear Area
Fire Missile

Conduct Post-Firing
Inspections

Execute Failure-to-
Fire Procedures

Lower Launcher
Safe the WHS
Disconnect Firing Device
Perform Failure-to-Fire
Troubleshooting Procedures
Reconnect Firing Device
Obtain New Orientation from
Remote Theodolite
Reorient Launcher

Perform Emergency
Destruction of Warhead

Insert Command Disablement Code
Set Shape Charge to Warhead
Evacuate Area
Destroy Warhead
Verify Destruction

Displace System

Secure Launcher
Leave Position

Action Step 1 (Alternative Method): Identify New System Operational Functions

Discussion

The analyst uses this action step as an alternative approach to developing New System operational functions.

A finite set of generic functions applies to all systems. From this generic set the analyst must identify the specific functions that apply to the New System. The analyst must also divide general, high-level functions into progressively more detailed subfunctions. By dividing the functions into subfunctions, the analyst will be better able to choose generic equipment in Substep 1.4 and to determine operator/maintainer tasks in Substep 1.8.

Procedures

1. **Develop High-Level New System Operational Functions.**
 - Examine Table 1.3-2, which provides a list of generic operational functions and subfunctions. From this table, select the high-level functions needed to perform each mission.
 - Review Appendix A for additional high-level functions that may be relevant to the New System. Refer to operational-function lists for the system types that are most similar to the New System.

NOTE

The analyst may need to expand individual high-level functions in Table 1.3-2; for example, the New System's primary function is to shoot or fire multiple rounds of various types of ammunition. Other functions listed do not apply; therefore, suggested subfunctions of the function Shoot may become high-level functions.

Table 1.3-2. Generic Operational Functions

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Mission Management	Plan Mission Prepare System Control Mission Execute Mission Evaluate Mission Operate Mission Equipment Perform Post-Mission Actions
Move	Displace/Emplace System Navigate System Fly System Drive System
Shoot	Acquire Target Attack Target Perform Post-Firing Procedures
Communicate	Transmit Messages Receive Messages Encode/Decode Messages Interpret Messages Process Messages
Perform Command and Control Actions	Sense Data/Information Collect Data/Information Process Data/Information Analyze Data/Information Manage Data/Information Decide on Action to Be Taken Take Action Disseminate Action
Perform Intelligence Actions	Perform Reconnaissance Seek Data/Information Sense Data/Information Detect Data/Information Process Data/Information Identify Data/Information Analyze Data/Information Track Data/Information Disseminate Action

2. Develop New System Operational Subfunctions.

- Return to Table 1.3-2 and the operational-function lists in Appendix A and identify applicable subfunctions. Add unlisted subfunctions and delete irrelevant subfunctions. (The analyst is not limited to the subfunction level of indenture indicated in Table 1.3-2 or the function lists in Appendix A.) Work toward a level of detail that will best suit the development of the generic equipment list in Substep 1.4 and operator/maintainer task lists in Substep 1.8.
- Record the high-level functions and their associated subfunctions on Worksheet 1.3-1.

Procedure 1 and 2 Examples

The All Source Analysis System (ASAS) is under development as part of a joint effort between the Army and Air Force to field a common and comprehensive Intelligence and Electronic Warfare (IEW) system. The system embodies the concept of tactical fusion, which involves combining information and reports from many sources and sensors and fusing them into a coherent, accurate system that delineates what is happening on a battlefield. Tactical fusion uses computers to assist in the correlation and display of intelligence in support of command decision making in combat operations.

The ASAS's required operational functions and corresponding subfunctions are:

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Mission Management	Plan Mission Accomplishment Evaluate Mission Performance Control Mission Performance Operate System
Communicate	Receive Messages Transmit Messages Perform Communication Processing Perform Communication Housekeeping
Perform Command and Control Actions	Perform Initial Information Processing (IIP) Perform Single Source Analysis (SSA) Perform All Source Processing (ASP) Perform Situation Development Perform Target Development Perform EW Support Provide OPSEC Support Display Information Draft Intelligence & Support Messages Manage Data

Action Step 2: Identify Non-Operational New System Functions

Discussion

The analyst identified system operational functions in Action Step 1. In this action step he or she determines non-operational system functions, for example, protect system, maintain system, supply system, and transport system. These functions can be accomplished by the system alone, by a combination of the system and some other system, or by another system. The analyst should be sure to include only those functions and systems within the analysis scope.

In some instances high-level non-operational functions may be at a sufficient level of detail for the analyst to derive generic equipment and tasks. The analyst should develop subfunctions only when high-level functions are not sufficiently detailed.

Procedures

1. **Identify New System Protective Functions.**
 - Determine high-level system protective functions for each mission by adding to or subtracting from the list of protective functions in Table 1.3-3.
 - Record the high-level protective functions on Worksheet 1.3-1.
 - Develop lower-level subfunctions, if necessary.
 - Record these subfunctions on Worksheet 1.3-1.
2. **Identify New System Maintenance Functions.**
 - Determine high-level system maintenance functions for each mission by adding to or subtracting from the list of maintenance functions in Table 1.3-3.
 - Record the high-level maintenance functions on Worksheet 1.3-1.
 - Develop lower-level subfunctions for each high-level maintenance function, if necessary.
 - Record these subfunctions on Worksheet 1.3-1.

3. Identify New System Supply Functions.

- Determine high-level system supply functions for each mission by adding to or subtracting from the list of supply functions in Table 1.3-3.
- Record the high-level supply functions on Worksheet 1.3-1.
- Develop lower-level subfunctions, if necessary.
- Record these subfunctions on Worksheet 1.3-1.

4. Identify New System Transport Functions.

- Determine high-level system transport functions for each mission by adding to or subtracting from the list of transport functions in Table 1.3-3.
- Record the high-level transport functions on Worksheet 1.3-1.
- Develop lower-level subfunctions, if necessary.
- Record these subfunctions on Worksheet 1.3-1.

Table 1.3-3. High-Level Non-Operational Functions

<u>Function Type</u>	<u>High-Level Functions</u>
Protective Functions	Provide Ballistic/Kinetic Protection Provide Chemical/Biological Protection Provide Nuclear/Electromagnetical Protection Provide Protection from Adverse Climates Avoid Detection
Maintenance Functions	Perform Corrective Maintenance Perform Preventive Maintenance Install Mission-Specific Equipment Repair Battle Damage Replenish System (Load System) Upgrade System Decontaminate System
Supply Functions	Supply Parts Supply Ammunition Supply Fuel Supply Power
Transport Functions	Prepare System for Transport Transport System

Procedure 1-4 Examples

The analyst determines the high-level non-operational functions for the All Source Analysis System (ASAS):

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>
Protective Functions	Provide Ballistic/Kinetic Protection Provide Chemical/Biological Protection Provide Nuclear/Electromagnetical Protection Provide Transportation Damage Protection
Maintenance Functions	Perform Corrective Maintenance Perform Preventive Maintenance Install Mission-Specific Equipment Upgrade System Decontaminate System
Supply Functions	Supply Parts Supply Power Supply Environmentally Required Equipment
Transport Functions	Prepare System for Transport Transport System

Action Step 3: Determine New System Functional Requirements

Discussion

In this action step the analyst uses the New System documents to identify functional requirements. A functional requirement states the attributes a system must have to accomplish its assigned missions. It describes the conditions in which a function must be performed and the level of performance at which the function must be performed.

Functional requirements are quantified in terms of performance measures and goals. A performance measure is a qualitative description of how a New System function is performed; for example, a performance measure for speed would be *miles per hour (mph)*, a performance goal is a quantitative criterion against which performance of the function will be assessed, for example, *eight mph over open terrain*.

No standard list of performance measures and goals exists for functions and subfunctions. These measures and goals vary with each system and its mission area. If performance measures and goals are not available in the New System documents, the analyst can determine them from the mission areas in which the system will likely operate. For example, a New System might be designed to fight in the direct fire, anti-tank, close-combat-light mission area. The analyst might assign 1,200 meters as the "maximum effective range" because this distance is the dividing line between the maximum effective range of light and heavy close-combat vehicles. The analyst can also identify performance measures and goals by referring to the existing system; for example, the New System must have improved accuracy of 10 percent over current system.

Procedures

1. **Determine Performance Measures and Goals for Each Function and Subfunction.**
 - Use the New System documents to identify a performance measure and goal for each function and subfunction.
 - If performance measures and goals are not in the New System documents, review the New System's likely mission areas. Identify New System functional requirements by comparing similar systems' functional requirements.
 - Record the performance measures and goals on Worksheet 1.3-1.

Procedure 1 Example

The analyst uses New system documents to determine performance measures and goals for the self-propelled, medium-range missile launcher.

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>Performance Measures</u>	<u>Performance Goals</u>
Prepare for March Order		Time: Mission Response. Hours	6
	Receive March Order	Time: Mission Response. Hours	1
	Receive Weapon from Assembly and Transport Section	Time: Mission Response. Hours	4
	Perform Pre-Operational Preventive Maintenance Checks & Services (PMCS)	Time: Maintenance Man-Hours	0.5
	Survey Firing Point	Time: Mission Response. Hours	1
Move to Firing Point			
	Start Engine	Time: Seconds	30
	Drive SPL	Time: Average. MIN	15.75*
		Maximum. MIN	21*
		Distance: Average. Miles	5.25*
		Maximum. Miles	7*
		Speed: Cruise. MPH	20
		Maximum. MPH	45

*Time and distance depend on mission duration. See the examples in Substep 1.5. Action Step 4.

(continued)

Procedure 1 Example (continued)

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>Performance Measures</u>	<u>Performance Goals</u>
Navigate		Accuracy: Meters	+/- 100*
	Identify Present Location	Time: Seconds Accuracy: Meters	180 +/- 100
	Identify Destination	Time: Seconds Accuracy: Meters	45 +/- 100
	Select Travel Route	Not Applicable (N/A)	
	Negotiate Selected Route. Monitor Current Location	N/A	
Communicate		Range: Kilometers (KM) Time: Seconds	25 8
	Transmit/Receive Messages	Range: KM Time: Seconds	25 8
	Encode/Decode Messages	Accuracy: %	100
	Communicate Using Countermeasures Procedures	Time: Seconds	8
	Use Vehicle Intercom for Crew Communication	N/A	
Emplace System		Time: Minutes Accuracy: Mils	15 +/- 50
	Position SPL Over Launch Stake	Time: Minutes Accuracy: Mils	1 +/- 50
	Shut Down Vehicle	Time: Minutes	3
	Prepare Vehicle for Firing Mode	Time: Minutes	3

*Time and distance depend on mission duration. See the examples in Substep 1.5. Action Step 4.

(continued)

Procedure 1 Example (continued)

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>Performance Measures</u>	<u>Performance Goals</u>
Emplace System (continued)	Inspect Main Missile Assembly (MMA) & War-head Section (WHS) for Damage	Time: Minutes	2
	Release Tie Down Straps. Traverse. & Lockpins	Time: Minutes	2
Prepare Weapon for Firing		Time: Minutes	3
		Accuracy: %	100
	Receive Firing Data	Time: Seconds	8
		Accuracy: %	100
	Turn on Monitor-Programmer	Time: Seconds	1
	Conduct Self-test	Time: Minutes	1
		Accuracy: %	95
	Determine Elevation & Azimuth	Time: Seconds	45
		Accuracy: Mils	+/- 0
Fire Weapon	Lay Weapon	Time: Minutes	1
		Accuracy: Mils	+/- 0
	Remove Protective Covers	Time: Seconds	20
		Time: Minutes	1
		Accuracy: %	100
	Arm WHS	Time: Seconds	1
	Insert WHS Settings	Time: Seconds	5
		Accuracy: %	100
	Move Firing Device to Firing Pit	Time: Seconds	15
	Elevate Missile	Time: Seconds	30
		Accuracy: %	100
	Place Selector in Launch Position	Time: Seconds	1
	Clear Area	Time: Seconds	15
	Fire Missile	Time: Seconds	1
Conduct Post-Firing Inspections		Time: Minutes	5

(continued)

Procedure 1 Example (continued)

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>Performance Measures</u>	<u>Performance Goals</u>
Execute Failure-to-Fire Procedures		Time: Minutes	12
		Accuracy: %	100
	Lower Launcher	Time: Seconds	30
	Safe the WHS	Time: Seconds	1
	Disconnect Firing Device	Time: Seconds	5
	Perform Failure-to-Fire Troubleshooting Procedures	Time: Minutes	10
	Reconnect Firing Device	Time: Seconds	5
	Obtain New Orientation from Remote Theodolite	Time: Seconds	8
		Accuracy: %	100
	Reorient Launcher	Time: Seconds	30
		Accuracy: %	100
Perform Emergency Destruction of Warhead		Time: Seconds	60
		Accuracy: %	100
	Insert Command Disablement Code	Time: Seconds	5
		Accuracy: %	100
	Set Shape Charge to Warhead	Time: Seconds	5
	Evacuate Area	Time: Seconds	20
	Destroy Warhead	Time: Seconds	1
	Verify Destruction	Time: Seconds	20
Displace System		Time: Minutes	3
	Secure Launcher	Time: Minutes	3
	Leave Position	Time: Minutes	1

Action Step 4: Allocate Functions

Discussion

In this action step the analyst allocates functions to hardware, software, and humans (operators, supporters, maintainers). The analyst can allocate functions to one system entity or to any combination of entities. The analyst will use this action step's results in Substep 1.4, Establish Generic Equipment Structure, and Substep 1.8, Determine Generic Tasks.

Procedures

1. **Allocate Functions to System Entities.**
 - Using as primary sources the Predecessor System information (Substep 1.2) and available documents on New System designs (Substep 1.2), allocate functions to system entities (hardware, software, humans).
 - Identify the functions allocated to humans as operator-, maintainer-, or supporter-performed functions.
 - Record the functional allocations on Worksheet 1.3-1.

Procedure 1 Example

The following allocation applies to the missile launcher described in the previous examples.

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	ALLOCATION				
		<u>Hardware</u>	<u>Software</u>	<u>O</u>	Humans* <u>S</u> <u>M</u>	
Prepare for March Order		X		X	X	X
	Receive March Order			X		
	Receive Weapon from Assembly and Transport Section	X		X	X	
	Perform Pre-Operational Preventive Maintenance Checks & Services (PMCS)	X		X		X
	Survey Firing Point	X		X		
Move to Firing Point		X	X	X		
	Start Engine	X	X	X		
	Drive SPL	X		X		
Navigate		X		X		
	Identify Present Location	X		X		
	Identify Destination			X		
	Select Travel Route			X		
	Negotiate Selected Route. Monitor Current Location	X		X		
Communicate		X	X	X		
	Transmit/Receive Messages	X		X		
	Encode/Decode Messages	X	X	X		
	Communicate Using Countermeasures Procedures	X		X		
	Use Vehicle Intercom for Crew Communication	X		X		

*O = Operator; S = Supporter; M = Maintainer

(continued)

Procedure 1 Example (continued)

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>ALLOCATION</u>			<u>Humans*</u>		
		<u>Hardware</u>	<u>Software</u>	<u>O</u>	<u>S</u>	<u>M</u>	
Emplace System		X		X			
	Position SPL over Launch Stake	X		X			
	Shutdown Vehicle	X		X			
	Prepare Vehicle for Firing Mode	X		X			
	Inspect Main Missile Assembly (MMA) & Warhead Section (WHS) for Damage	X		X			
	Release Tie Down Straps. Traverse. & Lockpins	X		X			
Prepare Weapon for Firing		X	X	X			
	Receive Firing Data	X	X	X			
	Turn on Monitor-Programmer	X		X			
	Conduct Self-test	X	X	X			
	Determine Elevation & Azimuth	X	X	X			
	Lay Weapon	X		X			
	Remove Protective Covers			X			
Fire Weapon		X	X	X			
	Arm WHS	X	X	X			
	Insert WHS Settings	X	X	X			
	Move Firing Device to Firing Pit	X		X			
	Elevate Missile	X		X			
	Place Selector in Launch Position	X		X			
	Clear Area			X			
	Fire Missile	X	X	X			
Conduct Post-Firing Inspections		X		X			

(continued)

Procedure 1 Example (continued)

<u>High-Level Functions</u>	<u>Lower-Level Subfunctions</u>	<u>ALLOCATION</u>			<u>Humans*</u>		
		<u>Hardware</u>	<u>Software</u>	<u>O</u>	<u>S</u>	<u>M</u>	
Execute Failure-to-Fire Procedures		X	X	X			
	Lower Launcher	X		X			
	Safe the WHS	X		X			
	Disconnect Firing Device	X		X			
	Perform Failure-to-Fire Troubleshooting Procedures	X		X			
	Reconnect Firing Device	X		X			
	Obtain New Orientation from Remote Theodolite	X	X	X			
	Reorient Launcher	X	X	X			
Perform Emergency Destruction of Warhead		X	X	X			
	Insert Command Disablement Code	X	X	X			
	Set Shape Charge to Warhead	X		X			
	Evacuate Area			X			
	Destroy Warhead	X		X			
	Verify Destruction			X			
Displace System				X			
	Secure Launcher	X		X			
	Leave Position	X		X			

**SUBSTEP 1.3
WORKSHEET**

WORKSHEET 1.3-1

Use this worksheet to document New System functions, functional requirements, and functional allocations.

High-Level Functions	Lower-Level Subfunctions	Performance		Allocation							
		Measures	Goals	HW	SW	Human					
						O	S	M			

Substep 1.4: Establish Generic Equipment Structure

Overview

In this substep the analyst establishes a hierarchy of generic equipment that performs the functions the analyst allocated to hardware in Substep 1.3 (Conduct New System Functional Analysis). The analyst uses an Equipment Identification Code (EIC) numbering system to develop this hierarchy. The equipment descriptions in this structure are generic; that is, they are more abstract than the actual equipment. The generic equipment structure is the basis for the Baseline Comparison System (BCS) and Proposed System equipment structures. Figure 1.4-1 is an overview of this substep.

The analyst creates the equipment hierarchy to break down the system into levels of indenture, including end item, system, subsystem, component/assembly, subcomponent/assembly, and part. (Detailed explanations of these levels are provided in Table 1.4-1.) When used with an EIC numbering system, this hierarchy becomes an analysis tool for comparing the Predecessor System, BCS, and Proposed System. An EIC (for example, a Functional Group Code [FGC], Work Unit Code [WUC], or Logistics Support Analysis Code [LCN]) provides information about a component's level of indenture and the system or subsystem to which the component belongs. Figure 1.4-2 depicts the various levels of indenture and typical numbering schemes for each level.

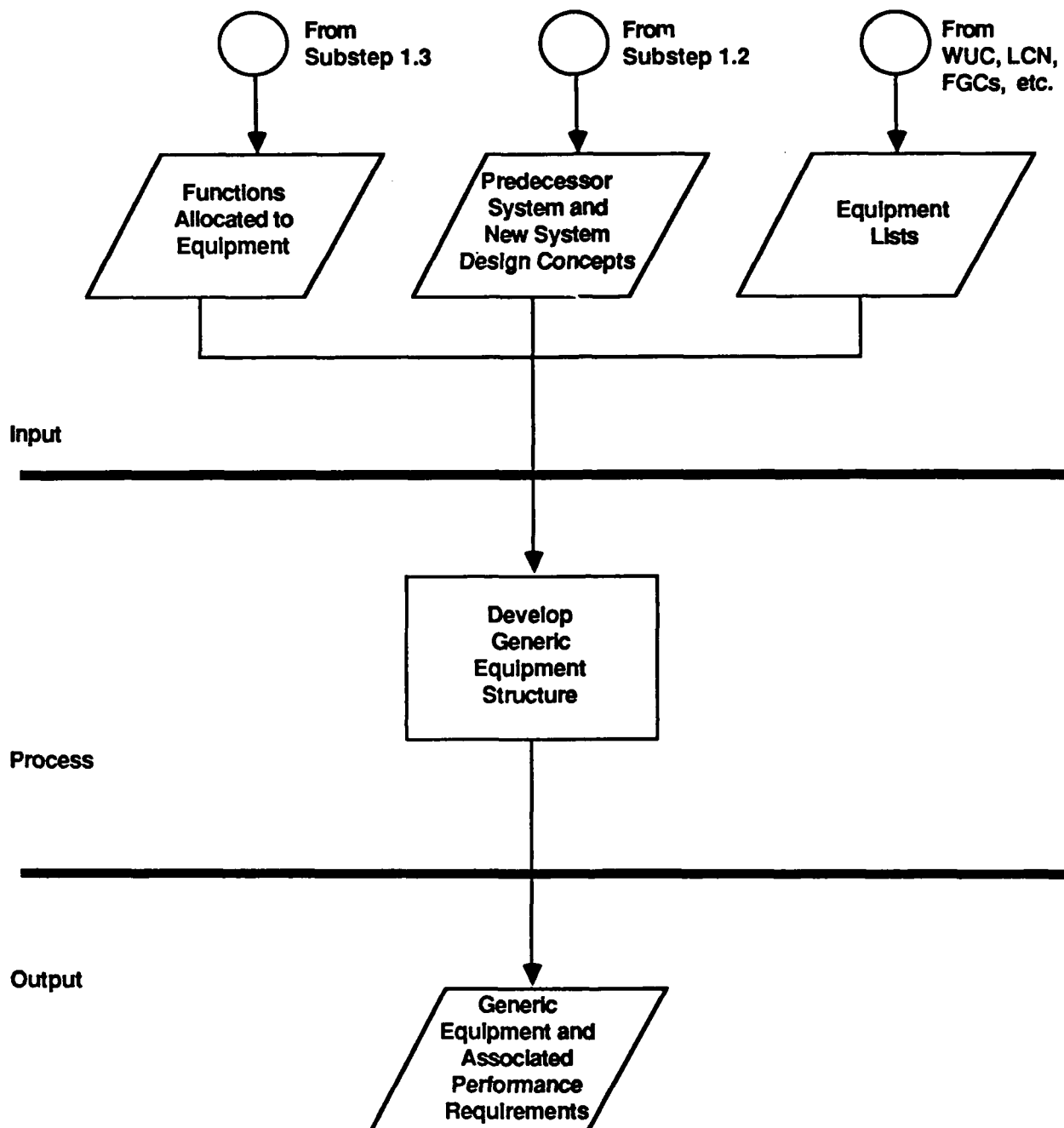


Figure 1.4-1. Overview of Substep 1.4, Establish Generic Equipment Structure.

Table 1.4-1. Levels of Indenture

- **End item** - A final combination of end products, component parts, and/or materiel that is ready for its intended use, e.g., missile, tank, aircraft, and radar.
- **System** - A complete system within an overall system, e.g., a hydraulic system, avionics system, armament system.
- **Subsystem** - A major portion of a system that performs a specific function in the overall operational function, e.g., the receiver/transmitter set, radar set, fire control computer.
- **Component/Assembly** - A number of parts or subassemblies or any combination thereof joined together to perform a specific function. In the HARDMAN Comparability Methodology (HCM), this term applies to items that cannot be further disassembled or repaired without shop facilities, e.g., a signal data converter, antenna, amplifier assembly.
- **Subcomponent/Assembly** - Those parts or subassemblies that comprise the next highest assembly (component/assembly). This level may not be required in an analysis.
- **Part** - One piece or two or more pieces joined together; not normally subject to disassembly without destruction of designed use. (The term "piece-part" is sometimes used for this level.)

LEVEL

End Item

System

Subsystem

Component/Assembly

Subcomponent/Assembly

Part

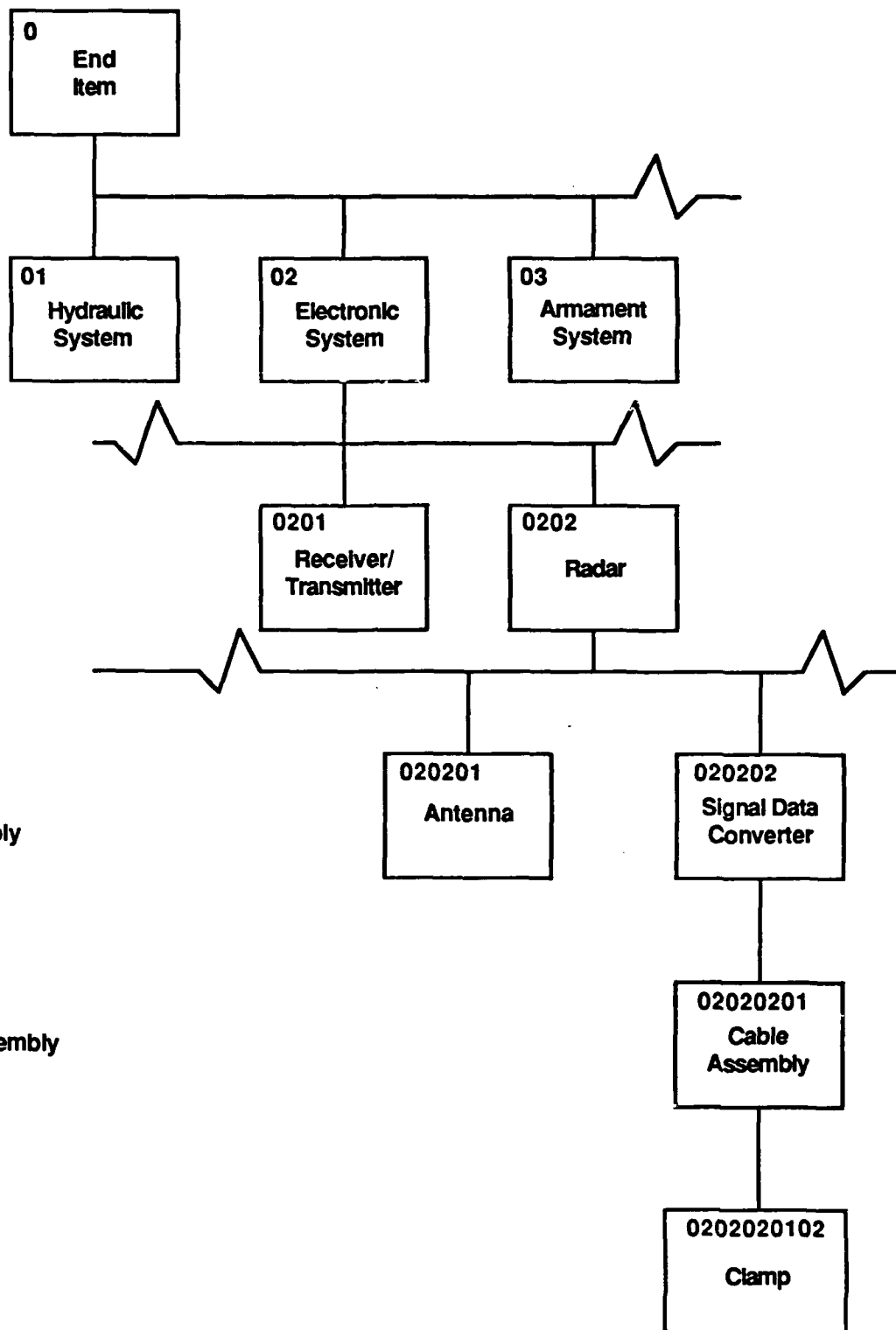


Figure 1.4-2. Levels of Indenture.

Action Step 1: Develop Generic Equipment Structure

Discussion

The analyst uses the procedures in this action step to develop a generic equipment structure for the New System functions allocated to hardware in Substep 1.3 (e.g., subfunction: communicate; generic equipment: Radio AM). The actual equipment is identified in Substeps 1.6 and 1.7 (e.g., generic equipment: Radio AM; actual BCS component: AN/ARC-115).

The analyst develops the generic equipment list in levels of indenture. Once he or she has established the generic equipment structure below the end-item level, the analyst proceeds to the next level. The engineering, manpower, and training analysts will work together to refine the generic equipment descriptions to provide the greatest possible detail.

Procedures

1. Obtain Equipment Documentation.
 - Obtain Predecessor System equipment lists (e.g., FGCs, WUCs, and LCNs).

NOTE

The analyst will find these equipment lists helpful in determining the existing level of indenture for the generic equipment structure.

- Obtain the New System equipment list and design concepts, if they are available.
2. Determine a Generic Equipment Requirement for Each New System Function Allocated to Hardware.
 - Obtain Worksheet 1.3-1 and identify those functions allocated to hardware.
 - Identify functions performed by the Predecessor System that are also required by the New System.
 - Using the Predecessor System equipment list as a guide, determine generic equipment requirements for each function. Incorporate any available New System design concepts.
 - Identify remaining functions that are not performed by the Predecessor System.

-
- Using research and professional judgment, determine generic equipment requirements for the functions not performed by the Predecessor System. Be sure to work with subject-matter experts and the Program Office while determining these requirements.
 - List on Worksheet 1.4-1 each New System function, that function's performance measures and goals (from Worksheet 1.3-1), an EIC, and the generic equipment name.

Procedure 1 Example

The analyst obtains the following extract from the CH-47 (CHINOOK) Helicopter WUC list. After examining this list, the analyst ascertains a level of indenture for the generic equipment list.

CH-47 WORK UNIT CODE STRUCTURE

11000	AIRFRAME
11100	FUSELAGE COMPONENTS
11110	MAINFRAME COMPONENTS
11130	AUXILIARY STRUCTURE COMPONENTS
11131	MAINTENANCE CRANE ASSY
11132	FLOOR ACCESS PANELS
11134	COCKPIT HEEL SLIDE ASSY
11135	COCKPIT FLOOR
11136	CABIN FUSELAGE FLOOR
11137	AFT CABIN FUSELAGE FLOOR
11150	PLATES/SKINS
11151	NOSE SECTION
11152	COCKPIT SKIN
11153	FORWARD PYLON SKIN
11154	CABIN FUSELAGE SKIN
11155	AFT CABIN FUSELAGE SKIN
11156	AFT CARGO DOOR SKIN
11158	AFT PYLON SKIN
11159	ACCESS PANELS
11200	DOORS
11210	PASSENGER/CREW DOORS
11211	PILOT JETTISONABLE DOOR ASSY
11212	COPILOT JETTISONABLE DOOR ASSY
11213	SPLIT CABIN DOOR ASSY
11230	EMERGENCY EXIT DOORS
11231	RESCUE HATCH
11231A	FLOOR RESCUE HATCH DOOR
11231B	LOWER RESCUE HATCH DOOR
11231C	CARGO DOOR ESCAPE EXIT ASSY
11232	HATCH ASSY, ESCAPE
11250	CARGO/BAGGAGE DOORS
11251	AFT CARGO DOOR ASSY
11252	CARGO DOOR ASSY
11253	CARGO DOOR ACTUATING MECHANISM
11270	SERVICE/ACCESS DOORS

(continued)

Procedure 1 Example (continued)**CH-47 WORK UNIT CODE STRUCTURE**

11271	XMSN TUNNEL COVER ASSY
11272	INTERPHONE JACK DOOR
11273	AFT PYLON SECTION
11274	FWD PYLON SECTION
11279	POD SECTION
11279K	NOSE ACCESS DOOR
11400	WINDOW COMPONENTS
11410	WINDSHIELD
11412	UPPER RH WINDOW ASSY
11412	UPPER LH WINDOW ASSY
114Z0	MISCELLANEOUS WINDOWS
114Z1	NOSE WINDOWS
114Z2	COCKPIT WINDOWS
114Z3	CABIN FUSELAGE WINDOWS
11B00	PYLON COMPONENTS
11B90	FILLETS/FAIRING
11B91	FWD PYLON FAIRING ASSY
11B92	AFT PYLON FAIRING ASSY
11D00	SPONSORS
11D10	MAIN FRAME COMPONENTS
12000	FUSELAGE COMPARTMENTS
12500	FLIGHT COMPARTMENT
12510	PILOT/COPILOT SEAT ASSY
125Z0	MISC EQUIP & FURNISHINGS
125Z1	REARVIEW MIRROR & STRAP ASSY
125Z2	PILOT/COPILOT RELIEF TUBE ASSY
125Z3	CHECK LIST
125Z4	ASHTRAY
125Z5	COCKPIT FIRE EXTING
12600	CABIN COMPARTMENT
12610	SEATS
12620	LITTER STOWAGE
12620	MISC EQUIP & FURNISHINGS
126Z1	PARATROOPER STATIC LINE
126Z2	MAP & DATE CASE
126Z3	EMERGENCY ESCAPE AXE
126Z5	ACOUSTIC INSULATION ASSY
12700	CARGO COMPARTMENTS
12710	CARGO TIE DOWN ASSY
127Z0	MISC CARGO COMPARTMENT COMPONENTS
127Z1	CARGO AREA FIRE EXTING

Procedure 2 Example

The analyst obtains Worksheet 1.3-1 and identifies the functions allocated to hardware. Two subfunctions for an aviation system are used in this example: Navigate Electronically and Provide Infrared Jamming.

Using the Predecessor System's equipment list as a guide, the analyst determines the following generic equipment requirements:

<u>Subfunction</u>	<u>EIC</u>	<u>Generic Equipment Name</u>
NAVIGATE	51000	INSTRUMENTS
ELECTRONICALLY	51100	FLIGHT INSTRUMENTS
	51110	PITOT STATIC SYSTEM
	51120	VERTICAL VEL COMPONENTS
	51130	AIRSPEED COMPONENTS
	51140	ALTITUDE COMPONENTS
	51150	ATTITUDE & DIRECTION COMPONENTS
	51153	VOR/LOC/ADF COURSE INDICATOR
	51190	TURN/SLIP COMPONENTS
	66000	EMERGENCY SYSTEMS
	66111	MARKER BEACON SET
	66112	PROXIMITY WARNING SET
	66113	MARKER BEACON ANTENNA
	66114	PROXIMITY WARNING ANTENNA
	67000	CNI SYSTEMS
	67111	ADF SET
	67112	VHF NAVIGATION SET
	67114	ADF SENSING ANTENNA
	67115	ADF LOOP ANTENNA
	67116	VHF NAVIGATION ANTENNA
	89900E	MULTI-MODE RADAR
	99100E	FORWARD LOOKING INFRARED (FLIR)

Because this aviation system's Predecessor System did not have electronic jamming capabilities, the analyst must determine the associated generic equipment:

PROVIDE	6900	COUNTERMEASURES SET
INFRARED	6904	OPERATOR CONTROL UNIT
JAMMING	6905	TRANSIT CASE
	6906	TRANSMITTER

**SUBSTEP 1.4
WORKSHEET**

WORKSHEET 1.4-1

Use this worksheet to document the generic equipment structure.

Function	Performance		Associated Generic Equipment	
	Measures	Goals	EIC	Generic Equipment Name

Substep 1.5: Identify Detailed Mission Requirements and Determine Usage Rates

Overview

The analyst's objectives in this substep are to divide the New System's missions into functions and missions events and to develop New System usage rates. A usage rate is the amount of system usage in miles driven, rounds fired, hours operated, etc., required over time to accomplish the system's missions. Figure 1.5-1 is an overview of this substep.

A usage rate consists of (1) a numeric value of the amount of usage, (2) an operating metric, and (3) a time period, for example, 560 rounds per week. The numeric value is 560, the operating metric is rounds, and the time period is a week.

The analyst's first step in determining usage rates is to array system functions over time to establish the temporal relationships among the functions. The analyst must then identify and place in sequence the mission events that comprise each function. Next, the analyst determines the operating metrics that best describe the New System's operations. The analyst then calculates the system's usage rates (in miles driven, rounds fired, hours operated, etc.) for the total number of cycles necessary to satisfy the scenario requirements.

To determine the New System's usage rates the analyst uses the New System's missions from Substep 1.1 (Identify General Mission Requirements) and system functions and functional requirements from Substep 1.3 (Determine Functional Requirements). He or she also uses the Mission Area Analysis (MAA), the New System's Operational and Organizational (O&O) Plan, including the Operational Mode Summary/Mission Profile (OMS/MP) if available, and general sources of doctrinal information such as the how-to-fight field manual series for the New System's mission area.

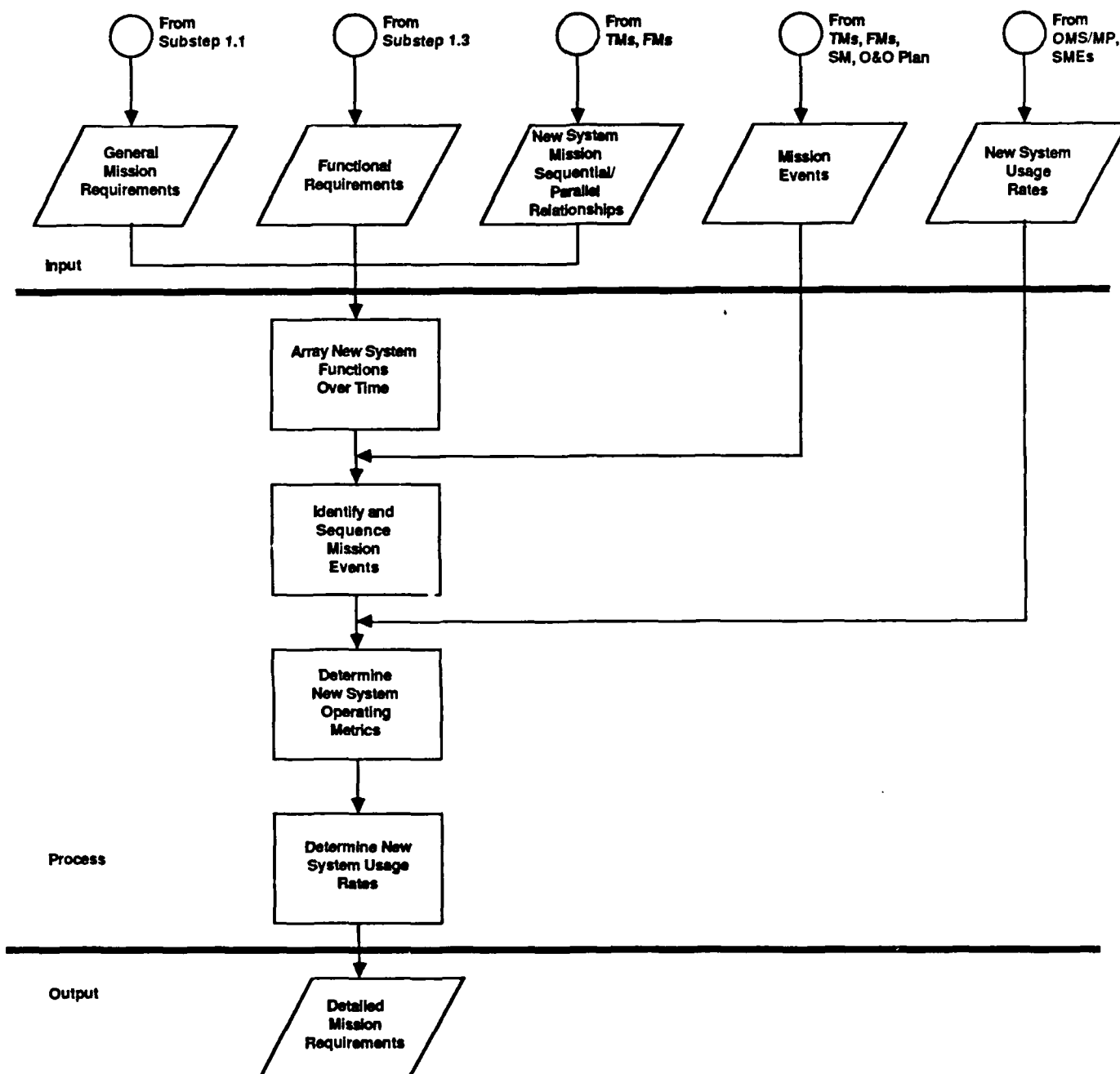


Figure 1.5-1. Overview of Substep 1.5, Identify Detailed Mission Requirements and Determine Usage Rates.

Action Step 1: Array New System Functions Over Time

Discussion

In this action step the analyst identifies the functions required to perform each mission. The analyst then establishes the temporal relationships among these functions by determining which functions are performed sequentially and which are performed simultaneously. The analyst arrays these functions in a timeline.

The analyst uses doctrinal field manuals to determine the temporal relationships among functions. These manuals include the how-to-fight series for the system's mission area; operator's manuals; soldier's and trainer's guides for the Predecessor System; and the New System's Operational and Organizational (O&O) Plan.

Procedures

1. Identify Functions for Each Mission.
 - For each mission identified in Substep 1.1, determine the functions identified in Substep 1.3 that support the mission (functions can support several missions). Be sure to consult subject-matter experts (SMEs) during this process.
 - Record each mission and its supporting functions on Worksheet 1.5-1.
2. Establish the Temporal Relationships Among the Functions.
 - Separate the functions into two categories: sequential and simultaneous.
 - Determine the temporal relationships by answering the following questions:
 - Assuming that all functions are essential to successful accomplishment of the mission, are all functions equally possible at any particular point in time, or must some functions be performed before others?
 - Are functions mutually exclusive?
 - Is it possible for the relationship among functions to vary according to the prevailing battlefield conditions?
 - Is the relationship among functions fixed either by doctrine or the constraints of the prevailing technology?
 - Plot the functions on a timeline.

Procedure 1 Example

The analyst obtains the list of specific missions for a self-propelled medium-range missile launcher (SPL). The example below lists only three of the SPL's missions.

- Mission 1: Destroy Enemy Fixed Emplacements
- Mission 2: Destroy Enemy Vehicles' Weapons
- Mission 3: Suppress/Deny Enemy Activity, Deny Terrain to Enemy

The analyst then obtains the functions and subfunctions.

<u>Function</u>	<u>Subfunction</u>
Prepare for March Order	Receive March Order Receive Weapon from Assembly and Transport Section Perform Pre-Operational Maintenance Checks & Services (PMCS) Survey Firing Point
Move to Firing Point	Perform Pre-Operation Maintenance Start Engine Drive SPL
Navigate	Identify Present Location Identify Destination Select Travel Route Travel Along Selected Route, Monitor Current Location
Communicate	Transmit/Receive Messages Encode/Decode Messages Communicate Using Countermeasure Procedures Use Vehicle Intercom for Crew Communication
Emplace System	Position SPL over Launch Stake Shut Down Vehicle Prepare Vehicle for Firing Mode Inspect Main Missile Assembly (MMA) and Warhead Section (WHS) Release tie down straps, traverse, and lockpins
Prepare Weapon for Firing	Receive Firing Data Turn on Monitor-Programmer Conduct Self-test

(continued)

Procedure 1 Example (continued)

<u>Function</u>	<u>Subfunction</u>
Prepare Weapon for Firing (continued)	Determine Elevation & Azimuth Lay Weapon Remove Protective Covers
Fire Weapon	Insert WHS Settings Arm WHS Move Firing Device to Firing Pit Elevate Missile Place Selector in Launch Position Clear Area Fire Missile
Conduct Post-Firing Inspections	
Execute Failure to Fire Procedures	Procedures Lower Launcher Safe the WHS Disconnect Firing Device Perform Failure to Fire Troubleshooting Procedures Reconnect Firing Device Obtain New Orientation from Remote Theodolite Reorient Launcher
Perform Emergency Destruction of Warhead	Insert Command Disablement Code Set Shape Charge to Warhead Evacuate Area Destroy Warhead Verify Destruction
Displace System	Secure Launcher Leave Position

The analyst then assigns the functions to the missions.

Function-to-Mission Assignment

<u>Mission</u>	<u>Functions Required</u>
Mission 1	Prepare for March Order Move to Firing Point Navigate Communicate

(continued)

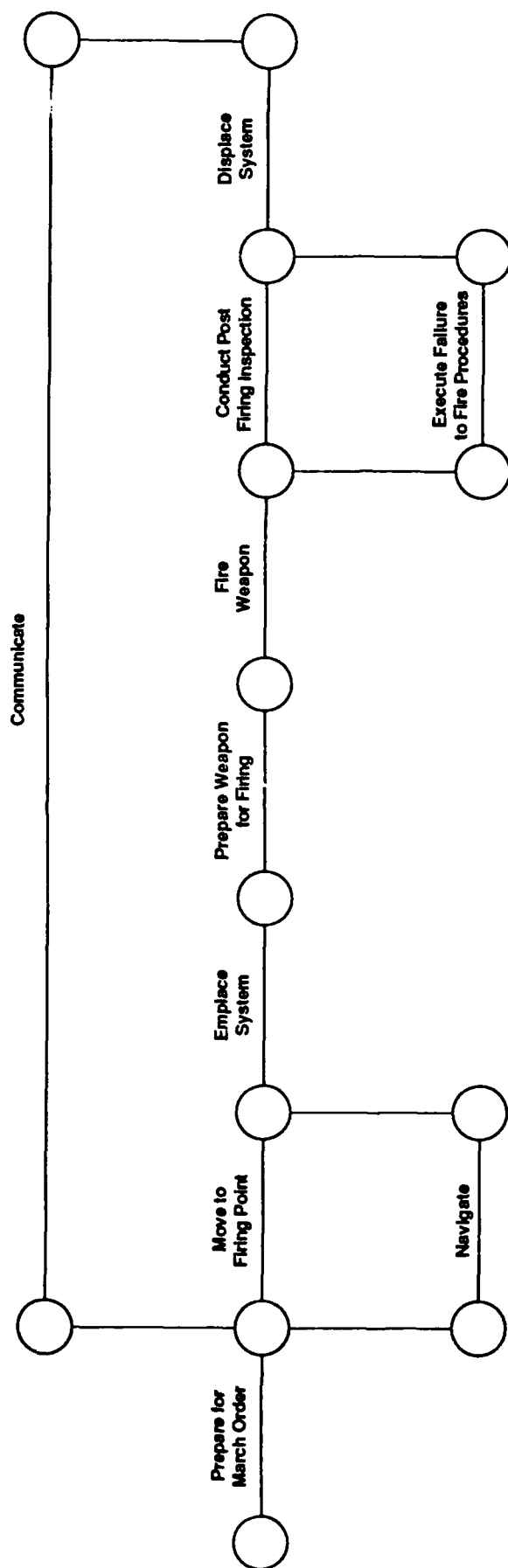
Procedure 1 Example (continued)

<u>Mission</u>	<u>Functions Required</u>
Mission 1 (continued)	Emplace System Prepare Weapon for Firing Fire Weapon Conduct Post-Firing Inspection Execute Failure-to-Fire Procedures Displace System
Mission 2	Prepare for March Order Move to Firing Point Navigate Communicate Emplace System Prepare Weapon for Firing Fire Weapon Conduct Post-Firing Inspection Execute Failure-to-Fire Procedures Displace System
Mission 3	Prepare for March Order Move to Firing Point Navigate Communicate Emplace System Prepare Weapon for Firing Fire Weapon Conduct Post Firing Inspection Execute Failure-to-Fire Procedures Displace System

Procedure 2 Example

As the analyst determines the timeline for the functions, he or she simultaneously indicates the category of the functions.

Figure 1.5-2 depicts the functional timeline for the SPL's Destroy Fixed Emplacements mission.



1.5-7

Figure 1.5-2. Timeline depicting temporal relationships of functions comprising the Destroy Enemy Fixed Emplacements mission.

Action Step 2: Identify and Sequence Mission Events

Discussion

The analyst uses the procedures in this action step to identify mission events. Mission events are discrete actions that comprise a function. Although mission events typically embody a function at a lower level of detail, a function can consist of only one mission event.

The primary sources of mission events are the same as for functions. These sources include the how-to-fight manuals for the system's mission area; operator's manuals; soldier's and trainer's guides for the Predecessor System; and the New System's Operational and Organizational (O&O) Plan.

As he or she did with functions in the previous action step, the analyst identifies mission events and then develops a timeline to determine the temporal relationships among them.

Procedures

1. **Identify Mission Events.**
 - Use research and professional judgment to identify the mission events each function requires. Be sure to consult SMEs during this process.
 - Record the mission events on Worksheet 1.5-1.
2. **Establish the Temporal Relationships Among the Mission Events.**
 - Separate the mission events into two categories: sequential and simultaneous.
 - Determine the temporal relationships by answering the following questions:
 - Given that all mission events are essential to successful accomplishment of the mission, are all mission events equally possible at any particular point in time, or must some mission events be performed before others?
 - Are mission events mutually exclusive?
 - Is it possible for the relationship among mission events to vary according to prevailing battlefield conditions?

-
- Is the relationship among mission events fixed either by doctrine or the constraints of the prevailing technology?

NOTE

Because mission events outnumber functions, mission events can be combined in more ways. Instead of a prescribed or definite sequence of mission events, several different sequences may be more appropriate to the system.

- Plot the mission events on a timeline.

Procedure 1 and 2 Examples

The example from Action Step 1 is continued here. The self-propelled medium-range missile launcher has two missiles. The system will operate by shuttling between a launch area, a hiding area, and a mission resupply point. A mission event begins when the system leaves the resupply point and ends after the system has fired both missiles and returns to the resupply point. The system may fire both missiles from one launch area; fire and move to a hiding area; or move to another launch area directly. The analyst must construct a sequence of events to cover the missile launcher's possible movements.

The analyst assumes that the system fires at least one missile once it enters a launch area. The analyst then constructs the mission-event-sequence diagram, as depicted in Figure 1.5-3.

Action Step 3: Determine System Operating Metrics

Discussion

In this action step the analyst identifies the operating metrics that best characterize the system and its subsystems. The Operational Mode Summary/Mission Profile (OMS/MP) provides most but not all of the essential system operating metrics. Military Standard 1388-2A, *DoD Requirements for a Logistic Support Analysis Record*, provides a list of operating metrics.

Procedures

1. Determine the Units of Measure that Relate to the Operational Requirements.
 - Examine the system functions and refer to Table 1.5-1 to determine the appropriate system metrics. Consult SMEs to ensure that the correct metrics have been chosen.

NOTE

Systems with multiple functions are typically described by more than one operating metric. These metrics apply to different subsystems.

2. Normalize the Operating Metrics, If Necessary.
 - Normalize the operating metrics only if the relationships among the metrics are constant. If the relationships are not constant, leave the metrics distinct.

Table 1.5-1. System Operating Metrics

<u>Time Related</u>	<u>Distance Related</u>	<u>Event Related</u>
Seconds	Miles	Cycles
Minutes	Nautical Miles	Starts
Hours	Kilometers	Landings
Days		Rounds
Months		
Years		
Flight Hours		
Operating Hours		

Procedure 1 Example

The analyst uses the OMS/MP to identify the operating metrics for the self-propelled, medium-range missile launcher.

Mission Profile

<u>Mission- Essential Function</u>	<u>Static</u>	<u>Dynamic</u>	<u>Ground Support</u>	<u>Annual Usage</u>
Fire Control (hours)	14	24	0	3.060
Shoot (rounds)	240	160	360	46.000
Mobility (miles)	12	30	30	3.300
Expected Percentage	75	20	5	N/A

<u>Climatic Design Type (AR 70-38)</u>	<u>% Fleet</u>	<u>Movement Terrain</u>
Hot	20	10% Primary Road
Basic	60	35% Secondary Road
Cold	15	55% Cross Country
Severe	5	

Source: TRADOC/AMC Pam 70-11, *RAM RATIONALE HANDBOOK*

Procedure 2 Example

A self-propelled howitzer is expected to fire 300 rounds daily and to operate 20 hours daily. The system will travel 15 miles per day between firing locations and the resupply point. The metrics are assumed constant for logistics planning purposes.

The analyst selects operating hours as the prime operating metric. He or she then normalizes the other metrics:

$$\frac{300 \text{ Rounds/Day}}{20 \text{ Operating Hours/Day}} = \frac{15 \text{ Rounds}}{\text{Operating Hour}}$$
$$\frac{15 \text{ Miles/Day}}{20 \text{ Operating Hours/Day}} = \frac{0.75 \text{ Miles}}{\text{Operating Hour}}$$

Action Step 4: Determine New System Usage Rates

Discussion

The analyst's objective in this action step is to determine each system's and subsystem's usage rate based on the appropriate operating metric. The analyst can calculate these usage rates or obtain them from the Army.

To determine the usage rate for one sequence of mission events, the analyst combines the system operating metrics, the sequence of mission events, and the scenario requirements contained in the OMS/MP. The analyst also determines the usage rate for the total number of sequenced mission events that will satisfy the scenario requirements.

NOTE

Before he or she performs this action step, the analyst must know whether he or she should use a prescribed usage rate (one rate for the system/subsystems) or develop individual rates for each subsystem metric identified in Action Step 3. This issue should have been resolved during the scoping of the analysis.

Procedures

1. Obtain New System Usage Rates.
 - Obtain the prescribed system usage rates directly from the Program Office or another official source. In some situations, several usage rates are prescribed for the subsystems, e.g., x miles, y rounds, z hours. If the Army provides such rates, the analyst does not complete Procedure 2.
2. Calculate New System Usage Rates.
 - Use research, professional judgment, and input from SMEs (particularly combat developers) to determine the appropriate numerical values for each operating metric within a mission event. Be sure that these values are acceptable to the Army.
3. Record the Usage Rates on Worksheet 1.5-2.

Procedure 1 Example

The analyst consults with the Program Office and obtains the following usage rates for a tank system. (A tank actually has many more subsystems than are shown below. This partial list is only an example.)

<u>Subsystem</u>	<u>Usage Rate</u>	<u>Operating Metric</u>
Engine	3500	Hours/Year
Track	2400	Miles/Year
Main Gun	8000	Rounds/Year

Procedure 2 Example

The analyst determines that the missile launcher described in previous examples has three operational modes and the following probability of being in these modes:

	<u>MODE</u>		
	<u>Surge</u>	<u>Intense</u>	<u>Sustained</u>
Missiles Launched Per Week	150	100	60
Expected Percentage of Time in Mode	10%	35%	55%

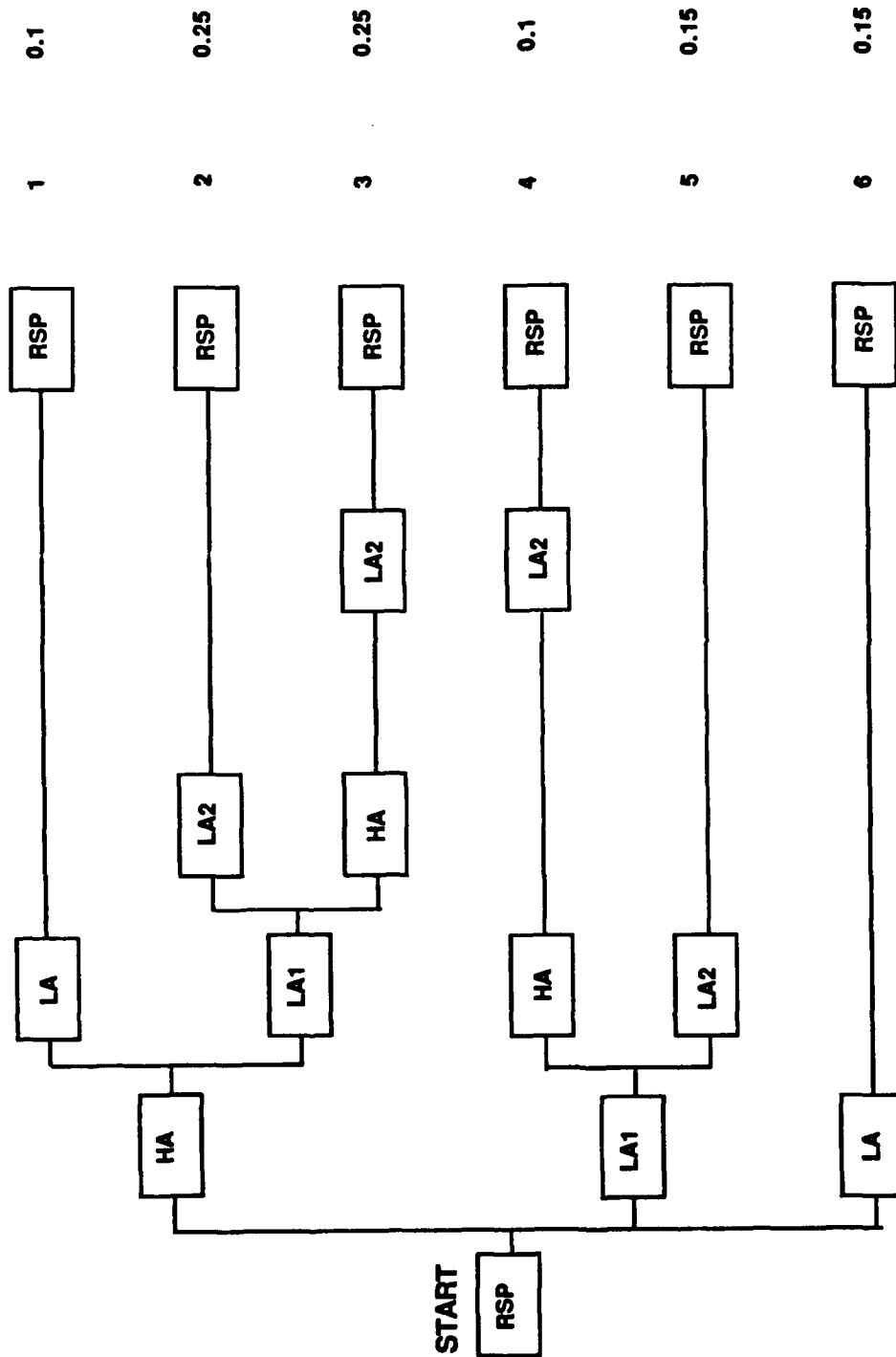
The analyst calculates the average number of missiles fired per week:

$$(150 \times .10) + (100 \times .35) + (60 \times .55) = 83 \text{ missiles/week}$$

The analyst also determines the total distance the missile launcher travels during one mission-event sequence. The analyst notes that the launcher may travel six unique paths during a mission-event sequence. After examining the system's O&O plan and holding discussions with SMEs, the analyst determines how often the system will follow a particular path as well as the average distances between the points. Each path, and its associated probability of occurrence, is depicted in Figure 1.5-4. The travel distances are:

<u>From</u>	<u>To</u>	<u>Average Distance (Miles)</u>
Resupply Point	Launch Area	2.0
Resupply Point	Hiding Area	1.0
Launch Area	Hiding Area	0.5
Launch Area	Launch Area	3.0

END PATH PROB.



LA = Launch Area Missiles 1 & 2
 LA1 = Launch Area Missile 1 Only
 LA2 = Launch Area Missile 2 Only
 RSP = Resupply Point
 HA = Hiding Area

Figure 1.5-4. Mission-event-sequence diagram with probabilities.

Procedure 2 Example (continued)

The analyst computes the average distance traveled for one mission-event sequence:

<u>Path</u>	<u>Distance Traveled on Path</u>	<u>Path Probability</u>	<u>Miles</u>
1	$1 + .5 + 0 + 2 = 3.5$	.10	.35
2	$1 + .5 + 3 + 2 = 6.5$	.25	1.625
3	$1 + .5 + .5 + .5 + 2 = 4.5$	.25	1.125
4	$2 + .5 + .5 + 2 = 5.0$	.10	.50
5	$2 + 3 + 2 = 7.0$	.15	1.05
6	$2 + 0 + 2 = 4.0$	.15	.60
Total			<u>5.25</u>

The analyst then determines the miles traveled to complete the weekly launch requirement of 83 missiles:

$$\begin{array}{l} 83 \text{ Missiles/Week} \\ 2 \text{ Missiles/Sequence} \end{array} \times 5.25 \text{ Miles/Sequence} = 217.9 \text{ Miles/Week}$$

**SUBSTEP 1.5
WORKSHEETS**

WORKSHEET 1.5-1

Use this worksheet to document the functions required to perform each mission.

Missions	Functions	Mission Events

WORKSHEET 1.5-2

Use this worksheet to document the New System's usage rates.

Subsystem	Usage Rates	Operating Metric

Substep 1.6: Establish Baseline Comparison System

Overview

In this substep the analyst selects Baseline Comparison System (BCS) equipment. This selection process is important because all subsequent HCM procedures and products are influenced by the BCS equipment list the analyst develops in this substep. Figure 1.6-1 is an overview of this substep.

The BCS must comply with the requirements of MIL-STD-1388-1A, *Logistics Support Analysis, Task 203*. The BCS is not an operational system or a fully integrated system. It consists of operational systems that satisfy the New System's design, operational, and support characteristics. The BCS is never built. It is a comparison system against which an analyst can assess Proposed System alternatives' human-resource requirements.

The BCS's components can be drawn from the Predecessor System and from other comparable existing systems in Army, DoD, NATO, or civilian inventories. The degree to which Predecessor System components are included in the BCS depends on whether the New System represents a Predecessor replacement or a Product Improvement Program (PIP). In a PIP, Predecessor and supplemental components are used for the BCS. For a New System with no Predecessor, the BCS is derived using components that accomplish the New System's functions.

Three types of components are involved in the selection of BCS equipment. A "potential" BCS component is any existing comparable component that satisfies a generic equipment requirement. A "candidate" BCS component is any existing comparable component that satisfies a generic equipment requirement and meets reliability and maintainability (R&M) data requirements. An "obvious" BCS component is any existing comparable component that satisfies a generic equipment requirement, meets R&M data requirements, and clearly fulfills all evaluation criteria.

Occasionally, the analyst will find more than one component that could fulfill the same generic equipment requirement. One component can be used to determine workload and the other component to develop training requirements. For example, if a Navy component is selected as a BCS component, the HCM training analyst will have greater difficulty using the Navy training course to determine Army training requirements. The analyst would use the Navy equipment for R&M and workload analysis and substitute an Army component for training analysis.

The analyst uses the system functions (Substep 1.3), the generic equipment structure (Substep 1.4), and the Predecessor System equipment and New System design concepts (Substep 1.2) to complete this substep. Information about the New System design(s) is extremely valuable. This information can include design concepts, preliminary designs, or detailed designs. A BCS that closely approximates the New System design will provide the most accurate HCM results.

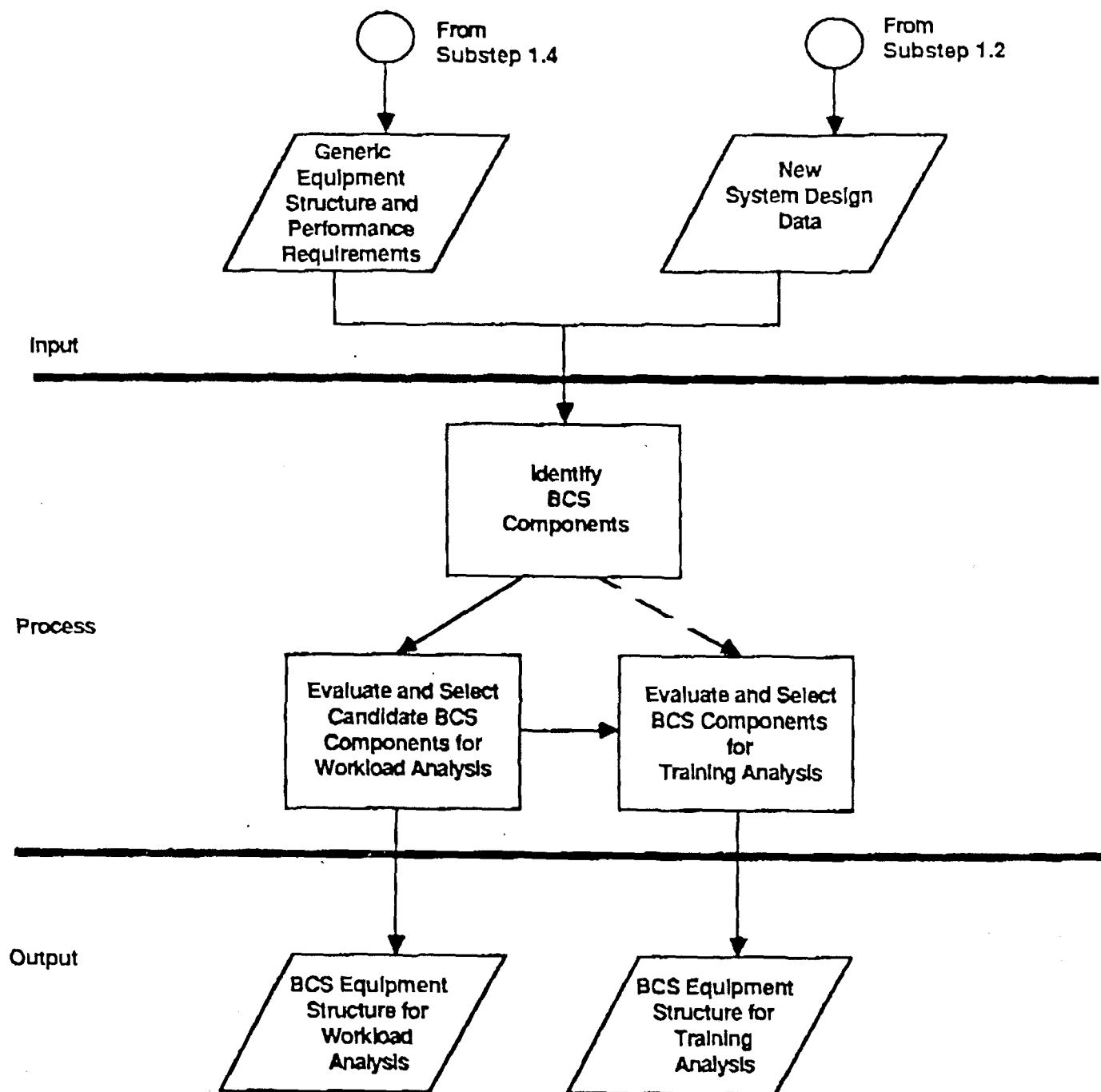


Figure 1.6-1. Overview of Substep 1.6, Establish Baseline Comparison System.

Action Step 1: Identify BCS Components

Discussion

In this action step the analyst identifies potential BCS components for each generic equipment requirement. The analyst then derives candidate and obvious BCS components from these potential BCS components.

Procedures

1. Determine Potential BCS Components.

- Obtain the generic equipment list (Substep 1.4).
- Identify potential BCS components for each generic equipment requirement by reviewing Army, DoD, NATO, and civilian inventories and identifying existing comparable components that satisfy the generic equipment requirements.
- Record the generic equipment, the potential BCS components, and the source on Worksheet 1.6-1.

NOTE

In some situations, the BCS component for a generic equipment requirement may be given, e.g., predecessor equipment not affected by a PIP or Government Furnished Equipment (GFE). In these cases, the analyst lists this equipment as the potential BCS component.

2. Determine Candidate BCS Components.

- Use Table 1.6-1 to determine whether the R&M data for each potential BCS component contain the required HCM data elements.
- Drop from consideration any potential BCS components that do not have the required R&M data elements. The remaining potential BCS components are the candidate BCS components.
- Record the candidate BCS components on Worksheet 1.6-1.
- Return to Procedure 1 if all potential candidate components have been eliminated for a particular generic equipment requirement.

3. Select Obvious BCS Components.

- Use Table 1.6-2 to evaluate each candidate BCS component.
- Record any obvious BCS components on Worksheets 1.6-1 and 1.6-3.

Table 1.6-1. R&M Data Element Requirements

To be considered a *candidate* for the BCS, a component must have the following data elements:

- Inherent failure rates (frequency of reliability-driven failures);
- Total Corrective Maintenance direct labor time;
- Preventive maintenance task time;
- Preventive maintenance task frequency;
- Maintenance level performing the task; and
- Maintenance data for all maintenance levels.

Table 1.6-2. Guidance for Selection of Obvious BCS Components

A BCS component should be added to the BCS equipment list when:

- The HCM is being applied to a system PIP. In this situation, all pieces of equipment not affected by the PIP are obvious BCS components.
- Only one candidate BCS component exists for a generic equipment requirement.
- A candidate BCS component is the exact component that the New System will use.
- An experienced analyst is familiar with the BCS component evaluation factors discussed in Action Step 2 and can quickly determine the "best" component from the list of candidate BCS components.

Procedure 1 Example - Potential BCS Component List

<u>Generic Equipment</u>	<u>Potential BCS Components</u>	<u>Source</u>
Airborne Infrared Detecting Set	AN/AAS-14A	Army
	AN/AAS-14B	Army
	AN/AAS-24	Army
TACAN Navigation Set	AN/ARN-102	Army
	AN/ARN-100(V)1	Army
	AN/ARN-103(V)2	Army
	AN/ARN-118	Army
Radar Data Transmitting Set	AN/AKT-18	Army
	CV1607/AVA-1	Navy
Airborne Laser Tracker	AN/AAS-32	Army
Digital Data Set	AN/USQ-61	Army
	AN/USQ-61A	Army
	AN/UYK-23	Army
	AYK-14(V)	Navy
Radar Mapping Recorder	RO-166/UP	Army
	RO-166A/UP	Army
	RO-166B/UP	Army
	RO-166C/UP	Army
	RO-166D/UP	Army
	RO-166E/UP	Army
	RO-166F/UP	Army
Head-Up Display	AN/AVQ-20	Air Force
	AN/AVQ-28	Navy
	Kaiser-built Display	Air Force
	IDHSS	Army

**Procedure 2 & 3 Examples - Candidate and Obvious BCS
Component List**

<u>Generic Equipment</u>	<u>Potential BCS Components</u>	<u>Candidate BCS Components</u>	<u>Obvious BCS Component</u>	<u>Remarks</u>
Airborne Infrared Detecting Set	AN/AAS-14A AN/AAS-14B AN/AAS-24	AN/AAS-14A AN/AAS-14B		The AN/AAS-24 was eliminated because it did not meet the basic data requirements.
TACAN Navigation Set	AN/ARN-102 AN/ARN-103(V)1 AN/ARN-103(V)2 AN/ARN-118		AN/ARN-103(V)2	The AN/ARN-103(V)2 was selected as an obvious BCS component because it met the basic data requirements and is the exact component projected for the New System.
Radar Data Transmitting Set	AN/AKT-18 CV/1607/AVA-1	AN/AKT-18 CV1607/AVA-1		Both potential components meet basic data requirements. They must be further evaluated in Action Step 2 to determine the best component.

Procedure 2 & 3 Examples - Candidate and Obvious BCS
Component List (continued)

<u>Generic Equipment</u>	<u>Potential BCS Components</u>	<u>Candidate BCS Components</u>	<u>Obvious BCS Component</u>	<u>Remarks</u>
Airborne Laser Tracker	AN/AAS-32		AN/AAS-32	The AN/AAS-32 was selected as an obvious BCS component because it met basic data requirements and was the only potential component identified.
Digital Data Set	AN/USQ-61 AN/USQ-61A AN-UYK-23 AYK-14(V)	AN/USQ-61 AN-USQ-61A AYK-14(V)		The AN-UYK-23 was eliminated because it did not meet the basic data requirements.
Radar Mapping Recorder	RO-166/UP RO-166A/UP RO-166B/UP RO-166C/UP RO-166D/UP RO-166E/UP RO-166F/UP		RO-166E/UP	The RO-166E/UP was selected as an obvious BCS component because it met the basic data requirements and is not affected by a system PIP.

Procedure 2 & 3 Examples - Candidate and Obvious BCS
Component List (continued)

<u>Generic Equipment</u>	<u>Potential BCS Components</u>	<u>Candidate BCS Components</u>	<u>Obvious BCS Component</u>	<u>Remarks</u>
Head Up Display	AN/AVQ-20 AN/AVQ-28 Kaiser-Built Display IDHSS	AN/AVQ-20 AN/AVQ-28 Kaiser-Built Display IDHSS		All potential components meet basic data require- ments. They must be fur- ther evalu- ated in Action Step 2 to de- termine the best com- ponent.

Action Step 2: Evaluate and Select Candidate BCS Components for Workload Analysis

Discussion

In this action step the analyst evaluates each candidate BCS component identified in Action Step 1 in terms of three criteria:

- (1) Performance and use characteristics;
- (2) Design similarity; and
- (3) R&M data quality.

The performance and use characteristics criterion includes three evaluation factors. The analyst compares each candidate BCS component's functional capabilities, operational environment, and usage rate with the New System's requirements.

The design similarity criterion includes four evaluation factors: hardware design, software design, equipment operation, and support system concept. The analyst compares each candidate BCS component's design with the New System's design concept (if available). This comparison depends largely on how well the New System is defined.

The R&M data quality criterion includes three evaluation factors: accuracy and validity, format and medium, and additional capability. Using these evaluation factors, the analyst examines each candidate BCS component's data quality. To be considered a candidate for the BCS, a component must have the data requirements discussed in Action Step 1, Table 1.6-2. In Action Step 2 the analyst evaluates the component's data source in terms of data accuracy and validity, format and medium, and ability to supply additional data elements.

For each evaluation factor, the analyst ranks the candidate BCS components (i.e., first, second, third, etc). Candidate BCS components can be "tied" in terms of how well they meet the New System's requirements. If two candidates are equally the best, both are ranked first.

Procedures

1. Evaluate Criterion 1 Evaluation Factors (Functional Capabilities, Operational Environment, and Usage Rates).
 - Use Tables 1.6-3 through 1.6-5 to evaluate the candidate BCS component's functional capabilities, operational environment, and usage rates (the tables begin on page 1.6-14).

-
- Rank the candidate BCS components in order from the best or most similar to the New System design to the worst or least similar. Record these rankings on Worksheet 1.6-2.

NOTE

A candidate BCS component can possess greater capabilities than the New System's required capabilities or can be deficient in its capabilities. Candidates with greater capabilities will generally be closer to the New System's requirements than deficient candidate BCS components.

2. Evaluate Criterion 2 Evaluation Factors (Hardware Design, Software Design, Equipment Operation, and Support-System Concept).
 - Use Tables 1.6-6 through 1.6-9 to evaluate the candidate BCS component's hardware design, software design, equipment operation, and support-system design.
 - Rank the candidate BCS components in order from the best or most similar to the New System design to the worst or least similar.
 - Record these rankings on Worksheet 1.6-2.

NOTE

The analyst should evaluate the candidate BCS component on only those factors applicable to the generic equipment requirement.

3. Evaluate Criterion 3 Evaluation Factors (Accuracy and Validity, Format and Medium, and Additional Capability).
 - Evaluate the candidate BCS component's data source using the quality-of-data evaluation factors contained in Tables 1.6-10 through 1.6-12.
 - Rank the candidate BCS components in order from the best data source to the worst.
 - Record these rankings on Worksheet 1.6-2.

4. Select One of the Candidate BCS Components.

- Use Worksheet 1.6-2 to select the candidate component that best meets the evaluation criteria. In most cases, a clear-cut "winner" will emerge. In those cases in which a winner is not apparent, assess each evaluation factor's level of importance. Examine the component's ranking for the
- more important evaluation factors and choose the component that best meets these more important evaluation factors.
- Record the selected BCS component on Worksheet 1.6-3.

Table 1.6-3. Functional Capabilities Considerations

When comparing the candidate BCS components' functional capabilities and specifications, the analyst should consider how closely each candidate meets the New System's requirements. The analyst first obtains generic equipment performance specifications for each component under consideration. He or she then compares candidate BCS components with these requirements and ranks first the component that most closely meets the requirements. The next closest candidate BCS component is ranked second and so on.

Table 1.6-4. Operational Environment Considerations

When comparing the candidate BCS components' operational environments, the analyst should consider how similar each candidate's typical operational environment is to the New System's projected operational environment. The analyst should take into account the following factors:

- Temperature;
- Humidity;
- Shock and vibration;
- Dirt and other particles; and
- NBC conditions.

Table 1.6-5. Usage Rate Considerations

When comparing the candidate BCS components' usage rates, the analyst should consider how closely each candidate meets the New System's requirements. The analyst first obtains New System usage-rate requirements for each piece of generic equipment identified and the corresponding candidate component usage rate. The analyst then compares the candidate BCS component usage rate with the New System requirements. He or she should consider the following factors:

- **Frequency of Use**
 - Continuous (24 hours per day)
 - Continuous for long periods of time
 - Continuous for short periods of time
 - Intermittent (randomly)
 - Intermittent (scheduled)
 - etc.
- **Usage-rate derivation; e.g., does the rate represent the actual component's usage rate or the entire system's usage rate?**

Table 1.6-6. Hardware Design Considerations

When comparing the candidate BCS components' hardware designs, the analyst should consider how similar each candidate's design is to the New System's design. The analyst should weigh the following factors:

- Physical dimensions (volume, weight, etc.);
- Modularity and component assembly;
- Redundancy in design;
- Technological level;
- Design interfaces, e.g., human interface with input and output devices;
- Equipment design interfaces, e.g., electrical, mechanical, fluid, etc.; and
- Required component test equipment (BIT/BITE, test points).

Table 1.6-7. Software Design Considerations

When comparing the candidate BCS components' software designs, the analyst should consider how similar each candidate's software design is to the New System's requirements. He or she should weigh the following factors:

- Independent Verification and Validation (IV&V) procedures
- Programming language:
- Modular code design:
- Capability for functional expandability:
- Code complexity:
- Design structure in terms of data flow and control, data distribution and storage, file/library accessibility, etc.:
- Degree of design redundancy for critical functions:
- Input requirements and methods required for operation and/or maintenance, such as menu-driven versus command procedures;
- Output requirements and displays required for operation and/or maintenance:
- Software environment, including computing system, operating system, utilities, input/output routines, libraries, etc.:
- Compatibility requirements with respect to hardware, other software, and communications:
- Interface standards for protocols, routines, and data representatives:
- Self-diagnostic capabilities:
- Security requirements:
- Maintenance and user documentation; and
- Degree of self-descriptiveness, i.e., quantity and effectiveness of program comments.

Table 1.6-8. Equipment Operation Considerations

When comparing the candidate BCS components' operation, the analyst should consider how similar each candidate's operation is to the New System's requirements. He or she should examine the following factors:

- Required skills of operators, including skill levels and specific knowledge requirements;
- Required operator tasks such as decisions, required input, and display assimilation;
- System/component cues;
- Pre/post operational checks;
- Performance monitoring actions;
- Emergency operations/actions;
- Special operations such as secure operation, actions for safe operation, actions for survivability.

Table 1.6-9. Support-System Concepts Considerations

When comparing the BCS components' support-system concepts, the analyst should consider how similar each candidate's design is to the New System's support-system concepts. He or she should take into account the following factors:

- Maintenance concept, including levels of maintenance;
- *Required maintainer skills and knowledge;*
- Current maintenance personnel;
- Maintenance task assignments;
- LRU level maintenance requirements/procedures;
- Required test equipment, including support and test, automated test, fault isolation to part groupings, and fault isolation certainty.

Table 1.6-10. Accuracy and Validity Considerations

When evaluating the candidate BCS components' data accuracy and validity, the analyst should consider the following factors:

- Field data source
- Data source agency
- Data collection methods
- Data recording methods
- Data output

Table 1.6-11. Format and Medium Considerations

When evaluating the candidate BCS components' data, the analyst should consider the following factors:

- Flexibility of data source to provide specific data parameters and requirements;
- Ability of source to provide "roll-ups," means, standard deviations, etc.;
- Data available only in hard copy;
- Data available on tape;
- Ease of data transfer;
- Timeliness of data delivery; and
- Specific data elements (what exactly is contained in data categories).

Table 1.6-12. Additional Data Factor Considerations

The analyst must determine whether the candidate BCS component's data source can provide the following additional data elements:

- Skill levels/paygrades of soldiers performing the action;
- Task descriptions;
- Task time allowances (make ready/put away etc.);
- Number of personnel performing task;
- Elapsed time;
- Task timelines;
- Task frequency of induced and other actions;
- Maintenance level: and
- Induced failures.

Procedure 1 Example

New System: Attack Helicopter

Component: Head-Up Display (HUD) Subsystem

The analyst evaluates the HUD subsystem in terms of the three BCS selection criteria. The example below does not show the BCS selection process for the Airborne Infrared Detecting Set, Radar Data Transmitting Set, and the Digital Data Set.

Performance and Use Characteristics

Factor: Functional Capabilities

New System HUD Requirements:

Specifications

Horizontal sweep view

Superimpose observed targets

Accepts multiple sensor inputs

Label targets

Performance

Survey terrain and airspace 70 to 80 degrees either side of aircraft.

Ground targets (vehicles and equipment), air targets

Sensor types: Forward-looking Infrared Radar (FLIR), Electro-optical (E-O), conventional radar

Identification, friends or foe (IFF) range to target

Candidate BCS Component Specifications:

<u>Head-Up Display</u>	<u>Description</u>	<u>Used on</u>
AN/AVQ-20	Head-up display in Air Force F-15 fighter serviced by computer from multimode radar AN/APG-63 input; air-to-air targets only	F-15
Kaiser-Built Display	Head-up display in Air Force F-16 aircraft serviced by Sperry computer from AN/APG-66 radar and television (E-O) inputs; air-to-air only	F-16
AN/AVQ-28	Head-up display in F/A-18 serviced by computer from multimode AN/APG-65 radar set and AN/ASQ-173 laser detector/tracker/camera set; has range capability, look-down capability for ground targets	F/A-18
Integrated Helmet Display Sight System (IHDS)	Head-up similar display in helmet-mounted mon-ocle; has FLIR, E-O, and radar images, range capability, air-to-ground, and air-to-air capability	AH-64A

(continued)

Procedure 1 Example (continued)

Candidate Comparison:

<u>Performance Requirements</u>	<u>AN/AVQ-20</u>	<u>Kaiser-Built Display</u>	<u>AN/AVQ-28</u>	<u>IHDSS</u>
Terrain sweep			X	X
Air sweep	X	X	X	X
70-80 degree	X	X	X	X
Ground targets			X	X
Air targets	X	X	X	X
FLIR				X
E-O	X	X	X	
Radar	X	X	X	X
Label IFF	X		X	X
Label range			X	X

The AN/AVQ-28 was a close second to the IHDSS. The AN/AVQ-20 and Kaiser-Built Display were a distant third and fourth.

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2. (This figure is located after the Procedure 4 example.)

Candidate Ranking:

AN/AVQ-20	3
Kaiser-Built Display	4
AN/AVQ-28	2
IHDSS	1

(continued)

Procedure 1 Example (continued)

Factor: Operational Environment

New System HUD Requirements: The HUD must operate in a typical attack helicopter environment. No other special requirements exist.

Candidate Comparison:

AN/AVQ-20	Operates in Air Force Fixed Wing Fighter
Kaiser-Built Display	Operates in Air Force Fixed Wing Fighter
AN/AVQ-28	Operates in Navy Fixed Wing Aircraft
IHDSS	Operates in Army Attack Helicopter

The candidate BCS components operational environments are similar. The IHDSS is ranked first because it is in an Army attack helicopter. The AN/AVQ-20 and the Kaiser-Built Display are tied for second, and the AN/AVQ-28 is last because Navy aircraft are subjected to salt air and high humidity, which increases workload due to corrosion control.

Candidate Ranking:

AN/AVQ-20	2
Kaiser-Built Display	2
AN/AVQ-28	3
IHDSS	1

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Factor: Usage Rate

New System HUD Requirements: The Army has prescribed that the New System shall fly 30 hours per month. Therefore, the analyst assumes that the head-up display subsystem will also be operational 30 hours per month.

Candidate Comparison:

AN/AVQ-20	40 hours per month
Kaiser-Built Display	40 hours per month
AN/AVQ-28	35 hours per month
IHDSS	20 hours per month

No large discrepancies exist between the candidate usage rates and the New System requirements. Candidate operational frequency and usage-rate derivation are also in line with the New System requirements. Each candidate is therefore ranked first.

(continued)

Procedure 1 Example (continued)

Candidate Ranking:

AN-AVQ-20	1
Kaiser-Built Display	1
AN/AVQ-28	1
IHDSS	1

Procedure 2 Example

Design Similarity

Factor: Hardware Design

New System HUD Design: No firm design concept exists for the HUD subsystem because the main weapon system is in an early stage of the acquisition process. Without a firm hardware design concept (glareshield-mounted HUD, helmet-mounted HUD, or other), the analyst may have difficulty drawing conclusions on the best BCS component based on hardware design. Hardware design will become an important BCS selection factor when the New System is designed (for example, a glareshield-mounted HUD).

Candidate Comparison/Ranking: Because a New System HUD design does not exist, this evaluation factor is not applicable. The analyst writes "NA" on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Factor: Software Design

New System HUD Requirements: Although detailed software requirements/specifications are not complete, some specifications have been made, including automatic data transfers in and out, compatibility for FLIR, E-O, and radar images input processing.

Candidate Comparison:

AN/AVQ-20	Automatic data transfer, radar input capability only
Kaiser-Built Display	Automatic data transfer, E-O and radar input capability
AN/AVQ-28	Automatic data transfer, E-O and radar input capability
IHDSS	Automatic data transfer, radar, E-O, and FLIR capability

(continued)

Procedure 2 Example (continued)

The IHDSS is the best choice because it meets both software requirements completely. The AN/AVQ-28 and the Kaiser-Built Display are tied for second because they meet only the radar and E-O input capability. The AN/AVQ-20 is fourth because it has only radar input capability.

Candidate Ranking:

AN/AVQ-20	3
Kaiser-Built Display	2
AN/AVQ-28	2
IHDSS	1

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Factor: Equipment Operation

New System HUD Requirements: The New System has a single-seat cockpit so only one pilot operates the HUD subsystem. Because of this requirement, the HUD must be easy to operate.

Candidate Comparison:

AN/AVQ-20	Designed for pilot use
Kaiser-Built Display	Designed for pilot use
AN/AVQ-28	Designed for pilot use
IHDSS	Designed for gunner position

The AN/AVQ-20, Kaiser-Built Display, and AN/AVQ-28 are ranked equally because they are each designed for pilot use. The IHDSS is ranked second because it is designed for the gunner position.

Candidate Ranking:

AN/AVQ-20	1
Kaiser-Built Display	1
AN/AVQ-28	1
IHDSS	2

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Procedure 3 Example

Data Quality

Factor: Accuracy and Validity

Candidate Comparison:

AN/AVQ-20	Air Force 66-1
Kaiser-Built Display	Air Force 66-1
AN/AVQ-28	Navy 3M
IHDSS	Army SDC

All data sources are reliable sources of R&M data.

Candidate Ranking:

AN/AVQ-20	1
Kaiser-Built Display	1
AN/AVQ-28	1
IHDSS	1

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Factor: Format and Medium

Candidate Comparison: The available formats and media depend on the data source. Using the considerations listed in Table 1.6-11, the analyst ranks the components as shown below.

Candidate Ranking:

AN/AVQ-20	1
Kaiser-Built Display	1
AN/AVQ-28	2
IHDSS	1

These rankings are recorded on Worksheet 1.6-2, shown in Figure 1.6-2.

Factor: Capability of Data Source to Provide Additional Data

Component Comparison/Ranking: Using the considerations listed in Table 1.6-12, the analyst ranks the candidate BCS components as follows:

(continued)

Procedure 3 Example (continued)

AN/AVQ-20	2
Kaiser-Built Display	2
AN/AVQ-28	2
IHDSS	1

These rankings are recorded on Worksheet 1.6-2, which is shown in Figure 1.6-2.

Procedure 4 Example

The results of the HUD subsystem analysis are shown in Figure 1.6-2. A clear-cut "winner" does not emerge. The analyst must therefore assess the evaluation factors for their level of importance. The analyst determines that functional capabilities, software design, equipment operation, and accuracy and validity factors are the most important factors. When the analyst examines these factors' rankings, the IHDSS candidate emerges as the best candidate. The analyst then adds the IHDSS to the BCS equipment list for the generic HUD requirement.

The BCS equipment for the generic equipment requirements identified in Action Step 1's example are shown below:

<u>Generic Equipment Requirement</u>	<u>BCS Equipment List</u>
Airborne Infrared Detecting Set	AN/AAS-14A
TACAN Navigation Set	AN/ARN-103(V)2
Radar Data Transmitting Set	CV 1607/AVA-1
Airborne Laser Tracker	AN/AAS-32
Digital Data Set	AN/USQ-61A
Radar Mapping Recorder	RO-166E/UP
HUD	IHDSS

WORKSHEET 1.6-2.

Use this worksheet to rank candidate BCS components.

Generic Equipment Requirement Number: 01800 Name: Head Up Display (HUD)										
Candidate BCS Component	PERFORMANCE AND USE CHARACTERISTICS CRITERION			DESIGN SIMILARITY CRITERION				DATA QUALITY CRITERION		
	Functional Capabilities	Operational Environment	Usage Rate	Hardware Design	Software Design	Equipment Operation	Support System Concept	Accuracy, Validity	Format, Medium	Additional Data
ANAVQ-20	3	2	2	N/A	4	1	2	2	1	2
Kaiser-built Display	4	2	2	N/A	3	1	2	2	1	2
ANAVQ-28	2	3	1	N/A	2	1	1	3	2	2
IHDSS	1	1	3	N/A	1	2	2	1	1	1

Figure 1.6-2. Example of Worksheet 1.6-2.

Action Step 3: Evaluate and Select BCS Components for Training Analysis

Discussion

In this action step the engineering and training analysts review the BCS equipment list developed in Action Step 2 to determine whether the selected BCS components adequately meet training-analysis requirements. The analysts evaluate each BCS component in terms of four criteria:

- (1) Weapon system proponent;
- (2) Training data completeness;
- (3) Training system maturity; and
- (4) Training concept.

If the BCS component does not meet training requirements, the analysts return to Action Step 1, where potential BCS components were identified for each generic equipment requirement. From the list of potential BCS components, the analysts choose those components that will best meet training-analysis requirements.

If the analysts must choose between an Army component and a civilian component or a component from another service branch, they should always choose the Army component -- even when for some reason or reasons (e.g., more sophisticated technology) the other component appears to be the better choice.

Using an Army component for training analysis drastically reduces the amount of analysis required and provides greater confidence in analysis results. Although it is possible to use a civilian component or a component from another service branch to estimate Army training requirements, these components make the analysis more difficult because their training systems and products are different. For example, both the Navy and Air Force training systems have entry-level technical courses that teach fundamental subjects. Recruits must attend a fundamental course before they can proceed to system-specific technical courses. It is difficult to equate this training to the Army task-oriented training system.

Procedures

1. Review the BCS Equipment List.
 - Examine each BCS component in the equipment list to determine whether it will meet training analysis requirements. Use Tables 1.6-13 through 1.6-16 to evaluate each BCS component in terms of the four criteria.
 - On Worksheet 1.6-4, record the BCS components that are acceptable for the training analysis. For those BCS components that are not acceptable, continue on to Procedure 2.
2. Review the Potential BCS Component List.
 - Review the potential BCS component list for those components that do not meet training analysis requirements.
 - Use Tables 1.6-13 through 1.6-16 to evaluate each potential BCS component.
 - Select a component for the training analysis and record it on Worksheet 1.6-4.

Table 1.6-13. Weapon System Proponent Considerations

When evaluating the BCS components weapon system proponent, the analyst should consider the following factors:

- Same Army proponent branch as New System. e.g., if the New System is a field artillery system, the component is from a field artillery system; and
- Same primary training location as New System.

Table 1.6-14. Training Data Completeness Considerations

When evaluating the candidate BCS components' training data completeness, the analyst should consider the following factors:

- **Program of Instruction (POI) data:**

For each course the component is taught in:

- Course number
- Optimum class size
- Armed Services Vocational Aptitude Battery (ASVAB) prerequisite
- Occupational specialty attending
- Training location

For each Annex/file/module the component is taught in:

- Annex/file/module number
- Annex/file/module title
- Types of instruction
- Length in hours
- Number of groups (student-to-instructor ratio)

- **If Substep 4.4. Determine Course Material Requirements, is to be conducted:**

- Equipment/Test Measurement and Diagnostic Equipment (TMDE) used, by hours
- Training devices used by hours
- Ammunition fired, by Department of Defense Instruction Code (DODIC)
- Facilities used, by hours
- Student to equipment/training device ratios

- **Task data:**

- Task number
- Task title
- Occupational specialty performing task
- Skill level
- Training references (e.g., technical manuals, supply bulletins, field manuals, etc.)
- Equipment/TMDE used in task performance
- Training products supporting the task
- Training devices supporting the task
- Training location
- Sustainment training frequency
- Sustainment training skill level

Table 1.6-15. Training System Maturity Considerations

When evaluating the BCS components' training maturity, the analyst should consider whether:

- Transition training requirements have been completed: i.e., transitional Additional Skill Identifier (ASI) courses and New Equipment Training (NET) courses have ended and component is taught in MOS-producing course;
- Training facilities, ranges, and other new training construction have been completed;
- Training devices, simulators, active equipment, and TMDE needed to support the component's training have been developed and acquired;
- Sustainment training products and programs, such as correspondence courses, training extension courses, and other exportable training have been completed and are available;
- No evidence of significant problem in soldier performance is associated with the component; i.e., trained entry-level soldiers are able to operate and maintain the component upon initial assignment; and
- TRADOC-developed POIs, Trainer's Guides, and Soldier's Manuals are available.

Table 1.6-16. Training Concept Considerations

When comparing the BCS components' training concepts, the analyst should consider how similar each component's training concept is to the New System's training concept. The analyst should take into account the following factors:

- Institutional training course requirements, especially the pipeline of course required to support the component;
- Sustainment training requirements, i.e., the types and amount of training products needed to sustain job proficiency;
- Collective/unit training requirements;
- Training equipment/device strategy, i.e., requirements for training with actual equipment versus use of such instructional technologies as training devices, simulators, part-task trainers, computer-based training (CBT), embedded training, etc.

Procedure 1 and 2 Example

The analyst uses the considerations in Tables 1.6-13 through 1.6-16 to evaluate the BCS components for the training analysis. In this example the analyst evaluates the following BCS components:

<u>Generic Equipment Requirement</u>	<u>BCS Equipment List for Workload Analysis</u>
Airborne Infrared Detecting Set	AN/AAS-14A
TACAN Navigation Set	AN/ARN-103(V)2
Radar Data Transmitting Set	CV1607/AVA-1
Airborne Laser Tracker	AN/AAS-32
Digital Data Set	AN/USQ-61A
Radar Mapping Recorder	RO-166E/UP
Head-Up Display	IHDSS

The analyst considers each component's proponent (Table 1.6-13) and determines that the CV1607/AVA-1, Radar Data Transmitting Set, is a Navy component that is not used on Army aircraft. The analyst reviews the potential BCS component list generated in Action Step 1 for other Radar Data Transmitting Sets. The analyst discovers that the AN/AKT-18 used on Army aircraft was identified as a potential BCS component and decides that this component is better suited for the HCM training analysis.

The analyst then uses the considerations listed in Table 1.6-14 to review the BCS equipment list. The analyst discovers that he or she has sufficient data for each of the BCS components identified except the AN/ARN-103(V)2, TACAN Navigation Set. The analyst reviews the potential TACAN Navigation Sets and selects the AN/ARN-118 because complete data are readily available for this component.

The analyst then uses Table 1.6-15 to review the BCS equipment list. The analyst discovers that all the identified BCS components have mature training systems. He or she makes no changes to the list.

Next, the analyst uses Table 1.6-16 to evaluate the BCS equipment list. The analyst discovers that all the BCS components except the AN/AAS-14A, Airborne Infrared Detecting Set, have similar training concepts to those being proposed for the New System. The AN/AAS-14A is 10 years old and is undergoing a Product-Improvement Program (PIP) upgrading it to the AN/AAS-14B. As part of this product improvement, the Army has acquired a new simulator similar to what is proposed for the New System. The analyst chooses the AN/AAS-14B as the training-analysis BCS component. Although the AN/AAS-14B does not have sufficient workload data to be selected for the BCS equipment list for workload analysis, it does have sufficient data to be included in the training analysis.

(continued)

Procedure 1 and 2 Example (continued)

The analyst records the training BCS equipment list as follows:

<u>Generic Equipment Requirement</u>	<u>BCS Equipment List for Workload Analysis</u>	<u>BCS Equipment List for Training Analysis</u>
Airborne Infrared Detecting Set	AN/AAS-14A	AN/AAS-14B
TACAN Navigation Set	AN/ARN-103(V)2	AN/ARN-118
Radar Data Transmitting Set	CV 1607/AVA-1	AN/AKT-18
Airborne Laser Tracker	AN/AAS-32	AN/AAS-32
Digital Data Set	AN/USQ-61A	AN/USQ-61A
Radar Mapping Recorder	RO-166E/UP	RO-166E/UP
Head-Up Display	IHDSS	IHDSS

**SUBSTEP 1.6
WORKSHEETS**

WORKSHEET 1.6-1

Use this worksheet to document the BCS equipment selection process.

Generic Equipment	Potential BCS Components	Source	Candidate BCS Components	Obvious BCS Components

WORKSHEET 1.6-2

Use this worksheet to rank candidate BCS components.

Generic Equipment Requirement Number: _____ Name: _____										
Candidate BCS Component	PERFORMANCE AND USE CHARACTERISTICS CRITERION			DESIGN SIMILARITY CRITERION				DATA QUALITY CRITERION		
	Functional Capabilities	Operational Environment	Usage Rate	Hardware Design	Software Design	Equipment Operation	Support System Concept	Accuracy, Validity	Format, Medium	Additional Data

WORKSHEET 1.6-3

Use this worksheet to document the BCS equipment list for Workload Analysis.

Generic Equipment	BCS Equipment

WORKSHEET 1.6-4

Use this worksheet to document the equipment list for the training analysis.

BCS Equipment for Workload Analysis	BCS Equipment for Training Analysis

Substep 1.7: Establish Proposed System

Overview

The analyst uses the procedures in this substep to identify Proposed System alternatives and to determine how each alternative differs from the Baseline Comparison System (BCS). Figure 1.7-1 is an overview of this substep.

A Proposed System is an analytical construct that represents the New System's design. As with the BCS, the analyst develops the Proposed System by identifying specific hardware components that perform New System functions. Unlike the BCS, however, the Proposed System must meet all New System requirements.

The analyst is not limited to one Proposed System in a HARDMAN Comparability Methodology (HCM) analysis. The number of Proposed Systems typically reflects the number of major technological approaches being considered (e.g., a gun design versus a missile design) or the number of unique design solutions offered by competing materiel contractors. The number of Proposed Systems to be studied should have been decided when the analysis scope was determined.

Proposed Systems can consist of actual subsystems/components (i.e., existing hardware/software or a proposed design obtained from a contractor or similar source) or a conceptual design developed by the HCM analyst. Actual components that meet all New System requirements are preferred but are often unavailable. The HCM analyst must therefore develop conceptual component designs that include projected technological advances and/or new operating and support concepts that will likely be included in the New System's design.

To develop conceptual component designs, the analyst compares BCS components with New System component requirements and/or Proposed System conceptual designs. He or she then identifies qualitative design differences between them. During this process the analyst uses the New System operational and support concepts identified in Substep 1.2, the New System functional requirements and performance characteristics developed in Substep 1.3, the generic equipment structure from Substep 1.4, and the BCS equipment list generated in Substep 1.6. Proposed System component designs, when available, are another important source. The analyst must also collect information on New System component design concepts and applicable new technologies to establish conceptual designs for all or part of the New System.

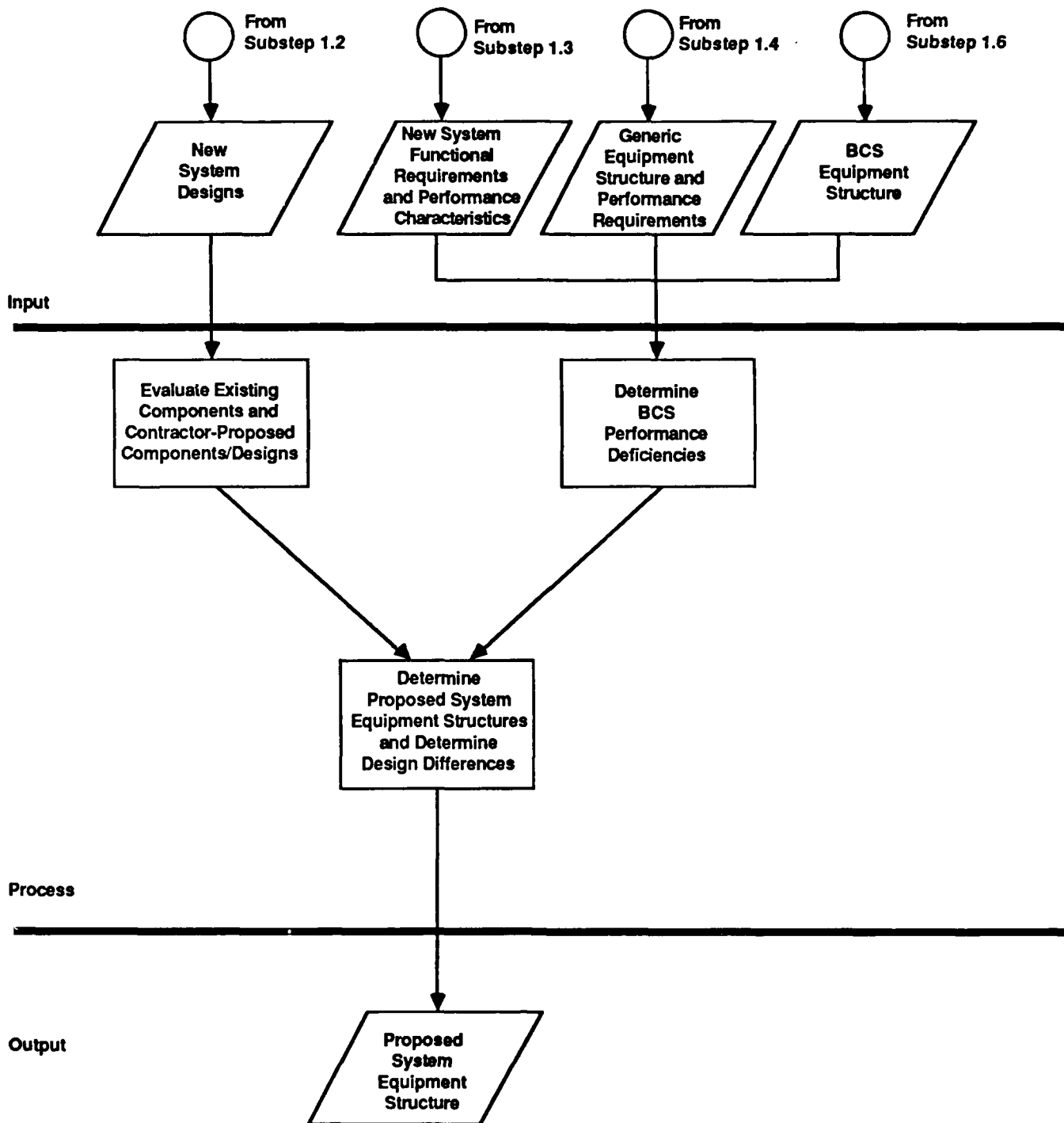


Figure 1.7-1. Overview of Substep 1.7, Establish Proposed System.

Action Step 1: Evaluate Existing Components and Contractor-Proposed Components/Designs

Discussion

In this action step the analyst collects available information on actual components, i.e., existing components and proposed contractor components/designs that meet the New System's requirements. The analyst evaluates these actual components and selects the components that possess the necessary data to qualify as Proposed System components.

The analyst performs Action Step 1 only if actual New System designs are available. Actual design information likely will not exist for HCM applications early in an acquisition.

NOTE

Even if proposed equipment designs are available, the analyst may still have to project elements of the support system design for that piece of equipment. For example, the analyst may have to define how the piece of equipment will be maintained and how the soldier will be trained.

Procedures

1. Obtain the New System's Requirements.
 - Obtain the New System subsystems/components from the generic equipment list. Record each component, by EIC, on Worksheet 1.7-1.
 - Obtain the corresponding New System subsystem/component functional performance requirements also listed in the generic equipment list. Record these performance requirements on Worksheet 1.7-1.
2. Identify Actual New System Subsystems/Components.
 - Obtain/review relevant information such as contractor proposals, engineering drawings, design documents, mock-ups, equipment prototypes, Logistic Support Analysis Record (LSAR) data, Developmental Test/Operational Test (DT/OT) data, etc.
 - Identify existing subsystems and/or components that meet the New System's requirements.
 - Identify contractor-proposed subsystem/component designs that meet the New System's requirements.

3. Determine Subsystem/Component Qualifications.

- Use Table 1.7-1 to evaluate the R&M data available for each subsystem/component identified in Procedure 1.
- Together with the training analyst, evaluate the training data available for each subsystem/component identified in Procedure 1. Be certain that the necessary data are available to complete the HCM training analysis.

NOTE

The minimum training data requirements will vary depending on the scope of the training analysis i.e., the particular training substeps to be included in the training analysis.

- If available data for the subsystems/components meet the minimum requirements, list the actual subsystem/component on Worksheet 1.7-1.
- If the available data for the subsystems/components do not meet the minimum requirements, investigate other data sources. If no data source meets the minimum data requirements, eliminate the actual subsystem/component from consideration and proceed to Action Step 2 of this substep.

**Table 1.7-1. Actual Subsystem/Component R&M Data Requirements
for Workload Analysis**

Minimum Requirements:

- Inherent failure rates (frequency of reliability-driven failures);
- Total Corrective Maintenance direct labor time;
- Preventive Maintenance task time; and
- Preventive Maintenance task frequency.

Procedure 1 through 4 Examples

The New System is a tracked vehicle. In this example generic equipment for the vehicle's suspension is used.

The analyst reviews existing component inventories and available contractor-proposed component/design information and determines that the components/designs listed below are available. Each component/design meets the New System's functional performance measures and goals and possesses sufficient R&M workload and training data.

Generic Equipment EIC and Name	New System Functional Performance Measures and Goals	Component
03 Suspension	<ul style="list-style-type: none">-Support vehicle movement. Provide contact between hull and contact surface. Transmit forces necessary to accel/decel. change direction and stop.-Enable vehicle speeds of 35 MPH (X-country) and 55 MPH (improved roads). Maintenance interval time: minimum of 6 months or 500 miles (whichever first).	LVIO Suspension System
0301 Track	<ul style="list-style-type: none">-Transmit engine power to ground. Transmit forces necessary to accel/decel, stop and turn. Distribute vehicle ground contact pressure over greater area.-Be capable of sustained speeds exceeding 55 MPH and have life expectancy of 2,000 miles. Maximum ground contact pressure not to exceed .54 kg/CM².	Type T-82/3 Track
0302 Shocks	<ul style="list-style-type: none">-Absorb impact forces generated during deflection of roadwheel arms over irregular surfaces.-Minimum life expectancy: 1,500 miles.	Type Ga6 Shock Absorber
0303 Roadwheels	<ul style="list-style-type: none">-Support track rotation. Control track along path of rotation.-Minimum life expectancy: 750 miles.	Continental RW-6 Roadwheels

(continued)

Procedure 1 through 4 Examples (continued)

Generic Equipment EIC and Name	New System	
	Functional Performance Measures and Goals	Component
0304 Torsion Bars	-Provide counterforce to roadwheel arm rotation to stabilize suspension. -Minimum life expectancy: 1,750 miles.	Type TB-28 Torsion Bar
0305 Drive Hub & Sprocket	-Transmit engine power from final drive to track. Transmit braking action to effect starting, stopping. -Minimum life expectancy: 1,000 miles.	SB-H7 Drive Hub and SB Sp9 Sprocket

Action Step 2: Determine BCS Performance Deficiencies

Discussion

In this action step the analyst identifies BCS component deficiencies by comparing the BCS components' performance characteristics with the New System's performance requirements. The analyst carries out this process for each component for which an actual component was not identified in Action Step 1.

Procedures

1. **Obtain Analysis Information.**
 - Identify each generic equipment requirement, by EIC, for which no available actual component/design qualifies.
 - Record this generic equipment, by EIC, on Worksheet 1.7-2.
 - Obtain from Substep 1.4 the New System's functional and performance requirements for each identified generic component/EIC.
 - Record these requirements on Worksheet 1.7-2.
 - Obtain from Substep 1.6 the corresponding BCS component for each generic component/EIC.
 - Record these BCS components on Worksheet 1.7-2.
2. **Determine the BCS Components' Functional and Performance Deficiencies.**
 - Compare the New System's functional and performance requirements with the BCS components' functional and performance capabilities. (BCS functional and performance capabilities can be obtained from Substep 1.6, Action Step 2).
 - Determine the BCS components' functional and performance deficiencies and record them on Worksheet 1.7.2.

Procedure 1 Example

The tracked vehicle example from Action Step 1 is continued here. No actual Environmental Control Unit (ECU) was identified in the New System documents; therefore, the analyst must determine the BCS ECU's deficiencies.

<u>Generic Equipment EIC and Name</u>	<u>New System Functional Performance Requirements</u>	<u>BCS Component</u>
0800 ECU	<p>Provide climate control (cooling/heating) to four-man tank crew during operations in complete MOPP suit. Provide filtered air in place of the M13A1 Gas Particulator Unit.</p> <p>1,000 hr. mean time between maintenance (MTBM). Minimum 9200 BTU to cool 72 cfm from 105° ambient to 65° ambient temperature for four-man tank crew. Must be operational with or without main engine operating.</p>	M14B Microclimate Cooling System. MBA Corporation Natick, MA

Procedure 2 Example

The analyst determines the following BCS component deficiencies:

- The main-unit size must be reduced by approximately 15 percent to fit in vehicle.
- The MTBM is 940 hours - a shortage of 6 percent.
- The ECU is unable to function with the engine off.

Action Step 3: Develop Proposed System Equipment Structures and Determine Design Differences

Discussion

In this action step the analyst uses actual components/designs identified in Action Step 1 and generic equipment for which no actual components/designs exist to develop Proposed System equipment structures. The analyst then establishes the design differences between BCS components and actual component designs or New System component design requirements, whichever is applicable.

Identifying design differences is a key step in determining MPT requirements. Differences that may affect MPT should therefore be the focus of this analysis.

Procedures

1. **Develop Proposed System Equipment Structures.**
 - On Worksheet 1.7-3, reorder by EIC all generic equipment requirements from Worksheets 1.7-1 and 1.7-2. For those components for which no actual design exists, record only the generic name on Worksheet 1.7-3. Leave the Component Name column blank.
2. **Identify Design Differences between BCS Components and Actual Component Designs.**
 - Locate generic equipment requirements for which a qualified component was identified in Action Step 1 (Worksheet 1.7-1).
 - Use Table 1.7-2 as a guide in identifying design differences between the actual components and corresponding BCS components.

NOTE

The analyst should provide as much information as possible about design differences to expedite subsequent procedures.

- Record these design differences on Worksheet 1.7-3 in the Design Difference Index column.

Table 1.7-2. Design Improvement Checklist

<u>Design Difference Categories</u>	<u>Potential Improvement Area</u>
Hardware Design	State-of-the-art technology
	Electrical design
	Mechanical design
	Size, weight, volume
	Component arrangement
	Redundancies
	Safety features
	Design for survivability
	Design for secure operation
	Design interfaces
	electrical connections
	cabling
	ducting
	fluid connections
	test points
	support equipment
	test equipment
	human input requirements
	display devices
	Support Requirements
	power requirements
	heating/cooling requirements
	self-test capabilities
	fuel requirements
	PHS&T requirements
Software Design	Independent Verification and Validation (IV&V)
	Programming language
	Coding complexity
	Design modularity

Table 1.7-2. Design Improvement Checklist (continued)

<u>Design Difference Categories</u>	<u>Potential Improvement Area</u>
Software Design (continued)	<p>Design structure (software functions and functional interfaces, data flow and control, data distribution and storage, file/library accessibility, system redundancies, and standard programming techniques)</p> <p>Provisions for expanding functional capability and data</p> <p>Design for secure operation</p> <p>Design for continuing operation under and recovery from abnormal conditions and component failure</p> <p>Design interfaces interface complexity interface standards for protocols, routines, and data representations software environment (computing system, operating system, utilities, input/output routines, libraries) compatibility with respect to hardware, other software, and communications human input requirements output displays</p> <p>Support requirements documentation program comments</p>
Equipment Operation	<p>Before-During-After operation checks</p> <p>Operator tuning/adjustment/calibration actions</p> <p>Operator equipment performance monitoring actions</p> <p>Operator support actions (refueling, reconfiguration, preservation, etc.)</p>

Table 1.7-2. Design Improvement Checklist (continued)

<u>Design Difference Categories</u>	<u>Potential Improvement Area</u>
Maintenance Concept	Operator skill requirements
	Operator choices/decisions
	Operator actions to continue operation under and recovery from abnormal conditions
	Operator actions for secure operation
	Operator actions for survival
	Operator input actions
	Operator output assimilation
	Maintenance levels and actions performed at each level
	LRU-level maintenance (e.g., repair, remove and replace, discard)
	Maintainer skill requirements and personnel categories (Service/Civil Service/contractor)
Training Concept	Automated test requirements
	BIT/BITE/diagnostic software fault isolation
	Support equipment
	Test equipment
	Tools
	Supply support
Operational Environment/ Tempo	Instructional responsibility
	Instructional methods
	Tasks trained
	Training devices and simulators
	Embedded training
	Protective equipment and clothing

Table 1.7-2. Design Improvement Checklist (continued)

<u>Design Difference Categories</u>	<u>Potential Improvement Area</u>
Operational Environment/ Tempo	Protective equipment and clothing
	Human fatigue
	Temperature
	Humidity
	Particulates
	Shock and vibration
	Noise
	Electromagnetic and Radio Impulse

3. Identify Design Differences between BCS Components and New System Component Design Requirements.

- On Worksheet 1.7-2, locate each generic equipment requirement for which no actual component was identified in Action Step 2.
- Using Table 1.7-2 as a guide, identify all design differences (technological, equipment, and support design) between the BCS components and the available New System design requirements. Evaluate design improvements required to enable the BCS to overcome its design differences (identified in Action Step 2).
- Record all design differences/improvements on Worksheet 1.7-3.

Procedure 1 and 2 Examples

The tracked vehicle example from Action Step 1 is continued here. On Worksheets 1.7-1 and 1.7-2, the analyst arranges each component according to its EIC.

The analyst determines the following design differences between the BCS suspension system components and the actual suspension-system components.

- The hub assembly utilizes 24 self-locking Torx head bolts for improved safety. The bolts are not reusable. The operator will require additional training to acquire the skills and knowledge needed to maintain them. The BCS uses 18 self-locking hex head bolts.
- The BCS components were selected from systems operating under a three-level maintenance concept. The New System will operate under a two-level concept.
- The operator requires additional skills to perform unit maintenance under the proposed two-level concept.
- The actual roadwheels are made of an alloy, which will result in a 50% increase in roadwheel weight over the BCS.
- The actual roadwheel bearings are oil lubricated. The BCS roadwheel bearings are grease lubricated.
- A special tool is required to remove torsion bars. Additionally, a complicated, four-man, step-by-step procedure is required to remove the #6 left side torsion bar. The BCS requires basic hand-tools and a three-man, three-step procedure.

Procedure 3 Example

The ECU example in Action Step 2 is continued here. The analyst identifies all design differences and required design improvements:

- Size and weight should be reduced by approximately 15 percent.
 - The MTBM must be improved by 6 percent.
 - The system requires a self-contained motor to operate its compressor when the engine is not running.
 - The compressor uses Torx head bolts, which require special maintenance tools.
 - The BCS requires special operating techniques and operator training in start-up and shut-down procedures to prevent the compressor from failing prematurely.
-

**SUBSTEP 1.7
WORKSHEETS**

WORKSHEET 1.7-1

Use this worksheet to document all Actual Subsystems/Component Information.

Generic Equipment		New System Component Functional Performance Requirements	Actual Subsystem/ Component
EIC	Name		

WORKSHEET 1.7-2

Use this worksheet to document BCS information for those components that no actual design exists.

Generic Equipment		New System Component Functional Performance Requirements	BCS Component	BCS Functional Performance Deficiencies
EIC	Name			

WORKSHEET 1.7-3

Use this worksheet to document the Proposed System equipment structure and Design Difference Index (DDI).

Proposed System Equipment Structure			Design Difference Index
EIC	Generic Name	Component Name	

Substep 1.8: Determine Generic Tasks

Overview

In this substep the analyst identifies generic operator and maintainer tasks for the functions that were allocated to humans in Substep 1.3. Figure 1.8-1 is an overview of this substep.

A "task" is a unit of work that constitutes a logical and necessary step in job/duty performance. In the HARDMAN Comparability Methodology (HCM), the manpower and training analysts view tasks from different perspectives. The manpower analyst regards tasks as bookkeeping devices for apportioning or accounting for system workload. The training analyst views tasks as the basis of the training analysis. The common set of tasks the engineering analyst develops in this substep prevents redundant, time-consuming task identification by both the manpower and training analysts.

To complete this substep the analyst will use detailed mission requirements (Substep 1.5), New System Functions (Substep 1.3), the Baseline Comparison System (BCS) equipment list (Substep 1.6), and the Proposed System equipment list and Design Difference Index (Substep 1.7).

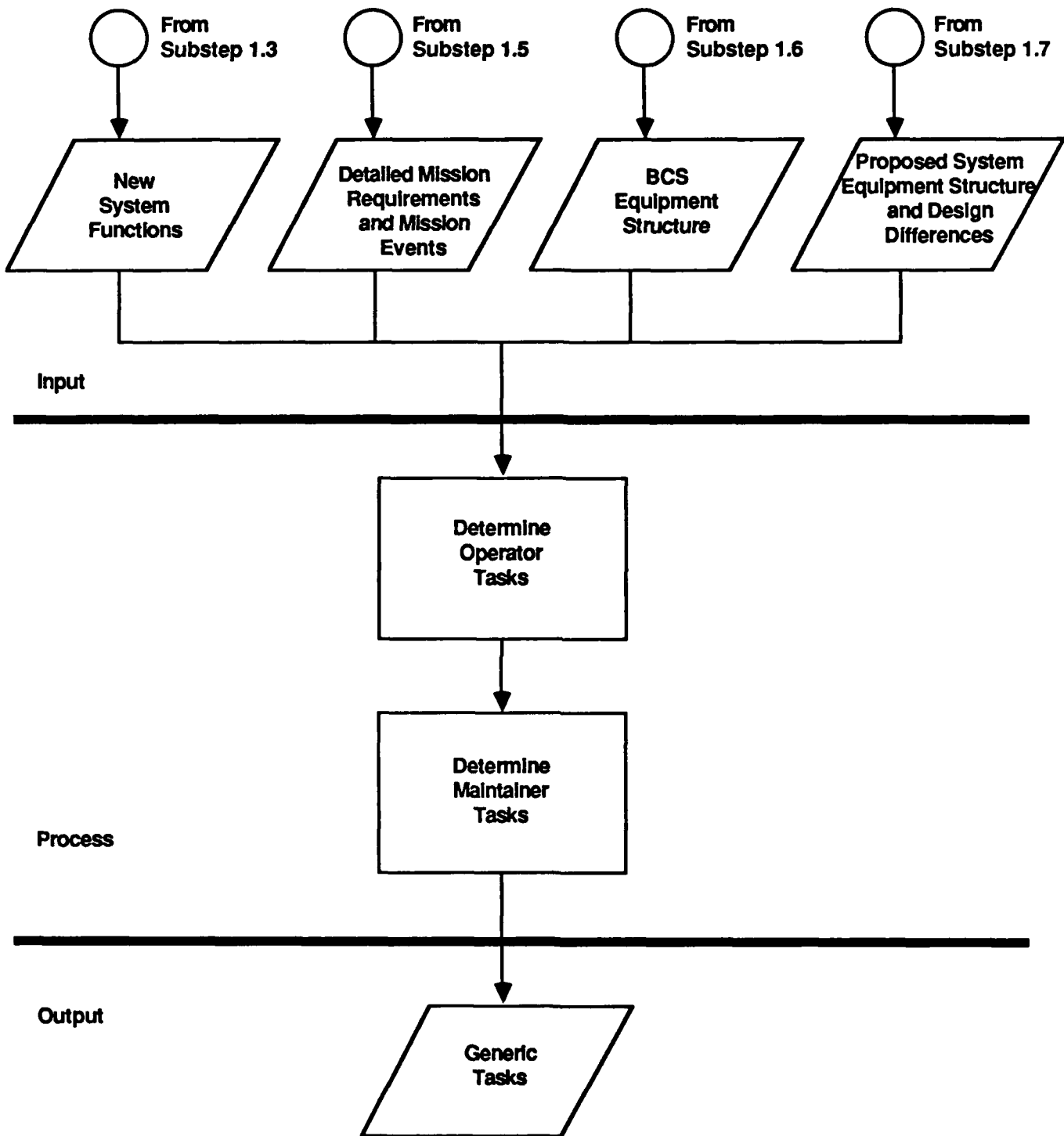


Figure 1.8-1. Overview of Substep 1.8, Determine Generic Tasks.

Action Step 1: Determine the Operator Tasks

Discussion

In this action step the analyst uses mission-analysis information and the functions allocated to the system operator (Substep 1.3) to identify the New System's operator tasks. The analyst must be sure to include every operator task in the operator-task list.

Procedures

1. **Identify Functions Allocated to the Operator.**
 - Obtain the functions from Worksheet 1.3-1 that have been allocated to the operator, including those functions allocated to the operator and system hardware/software.
 - Record these operator functions and subfunctions on Worksheet 1.8-1.
2. **Develop the Operator-Task List.**
 - Collect operator-task information from relevant operator's manuals, documents for similar weapon systems within the same functional branch, and other source documents.
 - Examine each New System function and its generic equipment and develop a list of tasks required to perform each function. Table 1.8-1 provides generic operator action words.

NOTE

Non-equipment-related tasks, especially those required for the command and control and communicate functions, are more difficult to determine than equipment-related tasks. Identifying these tasks requires greater analytical judgment and increases the analyst's reliance on comparable weapon systems.

- On Worksheet 1.8-1 record the operator tasks for each operator function.

Table 1.8-1. Generic Operator Action Words

Activate	Fly	Raise
Adjust	Grasp	Recognize
Aim	Group	Regulate
Align	Guide	Remove
Allocate	Identify	Replace
Arrange	Inspect	Respond
Assemble/ Disassemble	Install	Rotate
Assign	Isolate	Run
Calculate	Itemize	Schedule
Categorize	Lead	Select
Check	Listen For	Service
Classify	Load	Set up
Clean	Locate	Sharpen
Close/Open	Loosen	Slide
Collect	Lubricate	Sort
Compute	Maneuver	Specify
Connect/ Disconnect	March	Stencil
Construct	Match	Stow
Control	Mate	Synthesize
Coordinate	Mix	Tighten
Copy	Monitor	Trace
Detect	Navigate	Track
Diagnose	Observe	Transcribe
Direct	Operate	Translate
Distinguish	Order	Troubleshoot
Draft	Pick	Tune
Drive	Pick up	Turn On/Off
Energize/ De-Energize	Pilot	Twist
Evaluate	Plan	Wait
Fire	Prepare	Watch
	Press	Weld
	Pull	Write
	Push	

Procedures 1 and 2 Examples

A self-propelled missile launcher's functional requirements were shown in an example in Substep 1.3. Listed below are the operator tasks for a sample set of these functions.

<u>Function</u>	<u>Subfunction</u>	<u>New System Tasks</u>
Prepare Weapon for Firing	Receive Firing Data	Determine Target Location & Type
	Turn on Monitor-Programmer	Energize Monitor-Programmer
	Conduct Self-test	Press Self-test Button Verify System Operation Compensate for Equipment Malfunction
	Determine Elevation & Azimuth	Enter Firing Data into Computer Verify Accuracy of Computer Output
	Remove Protective Covers	Release Straps & Covers Stow in Secure Position
	Lay Weapon	Set Elevation & Azimuth Coordinates Verify Elevation & Azimuth Settings
Fire Weapon	Arm Warhead Section (WHS)	Move Gunners Station Safety Switch to Arm
	Insert WHS Settings	Enter Data into Computer
	Move Firing Device to Firing Pit	Pick up Firing Device Carry to Selected Firing Pit Run Wire from WHS to Firing Device Connect Wire

(continued)

Procedures 1 and 2 Examples (continued)

<u>Function</u>	<u>Subfunction</u>	<u>New System Tasks</u>
Fire Weapon (continued)	Elevate Missile	Activate Elevation Control on Remote Firing Device Raise to Selected Coordinate Place Selector in Launch Position Move Gunner's Station Safety Switch to Launch Mode
	Clear Area	Run to Firing Pit Account for All Personnel
	Fire Missile	Activate Firing Sequence

Action Step 2: Determine the Maintainer Tasks

Discussion

The analyst uses the procedures in this action step to develop maintainer-task lists (actions) for each BCS and New System component. In Substep 1.9 (Determine Reliability and Maintainability Requirements) the analyst will use these lists, which take into account each maintenance level in the HCM analysis, to ensure that all maintenance associated with a component is included in the maintenance-ratio calculation. (The manpower and training analysts will also use these maintainer-task lists in their analyses.)

Procedures

1. **Develop a Maintainer-Task List for Each Component at Each Maintenance Level.**
 - For each component in the New System and the BCS, develop a list of the tasks required to maintain the component. Table 1.8-2 contains generic maintainer action words. (The analyst is not limited to the words in this table.)

NOTE

The level of detail at which a task is stated depends strictly on the level of indenture (and detail) in the generic and New System equipment structures.

- On Worksheet 1.8-2 record the maintainer tasks for each component in the BCS and New System equipment structures.

Table 1.8-2. Generic Maintainer Action Words

Adjust
Align
Calibrate
Clean
Inspect
Install
Overhaul
Purge
Rebuild
Remove
Remove and Replace
Repair
Service
(Technical) Inspect
Test
Troubleshoot
Weld

Procedure 1 Example

The analyst assigns maintainer tasks to the UH-60A helicopter's components.

<u>Component</u>	<u>Associated Maintainer Tasks</u>
Main Rotorhead Assembly	Adjust Align Clean Inspect Install Overhaul Remove Remove and Replace Repair (Technical) Inspect Test Troubleshoot
VHF-FM Radio System (AN/ARC-114A)	Adjust Inspect Remove and Replace Repair Test Troubleshoot
Airspeed Indicator	Adjust Calibrate Inspect Overhaul Remove Remove and Replace Repair Service (Technical) Inspect Test Troubleshoot

**SUBSTEP 1.8
WORKSHEETS**

WORKSHEET 1.8-1

Use this worksheet to document operator tasks.

Function	Subfunction	New System Operator Tasks

WORKSHEET 1.8-2

Use this worksheet to document maintainer tasks.

Function	Subfunction	BCS Maintainer Tasks	New System Maintainer Tasks

Substep 1.9: Determine Reliability and Maintainability Requirements

Overview

The analyst's objective in this substep is to determine reliability and maintainability (R&M) characteristics for the Predecessor System, Baseline Comparison System (BCS), and Proposed System. Figure 1.9-1 is an overview of this substep.

R&M characteristics are described in terms of a maintenance ratio (MR). An MR is the ratio of required maintenance man-hours per operating metric (e.g., hours, rounds, miles). Required maintenance man-hours are based on R&M system characteristics only (excluding combat-damage considerations). The R&M system characteristics consist of both inherent and induced direct maintenance time, including Corrective Maintenance (CM) and Preventive Maintenance (PM).

Inherent maintenance actions are a result of the system's characteristics, for example, problems with its design, hardware, software, or manufacturing quality control. Induced maintenance actions are a result of the system's operating environment, for example, shortcomings in the skills of its operators and maintainers, the availability of spare parts, or the readability of technical documents.

Corrective Maintenance is unscheduled maintenance resulting from malfunction, failure (both induced and inherent failures), deterioration, or battle damage. Corrective maintenance actions are required to restore disabled systems, equipment, or components to an operational condition within predetermined tolerances and limitations. Corrective Maintenance includes such activities as repairing broken pipes, replacing a burned transformer, and patching a ripped canvas cover.

Preventive Maintenance is conducted at scheduled, periodic intervals on operational systems, equipment, or components. Preventive Maintenance contributes to uninterrupted system operation. It involves such tasks as checking fluids prior to operating, cleaning and lubricating daily, and rotating annually.

The analyst must use mature, historical R&M data as sources for Predecessor System and BCS data parameters and resulting MRs. The analyst can use two methods to obtain or develop R&M data for the New System components. The first method is based on the availability of R&M data for actual components. The second method involves developing R&M data when actual components do not exist.

Actual R&M data may be available from prime contractor estimates, Logistics Support Analysis Records (LSARs), developmental and operational test results, or early field data if New System component designs exist.

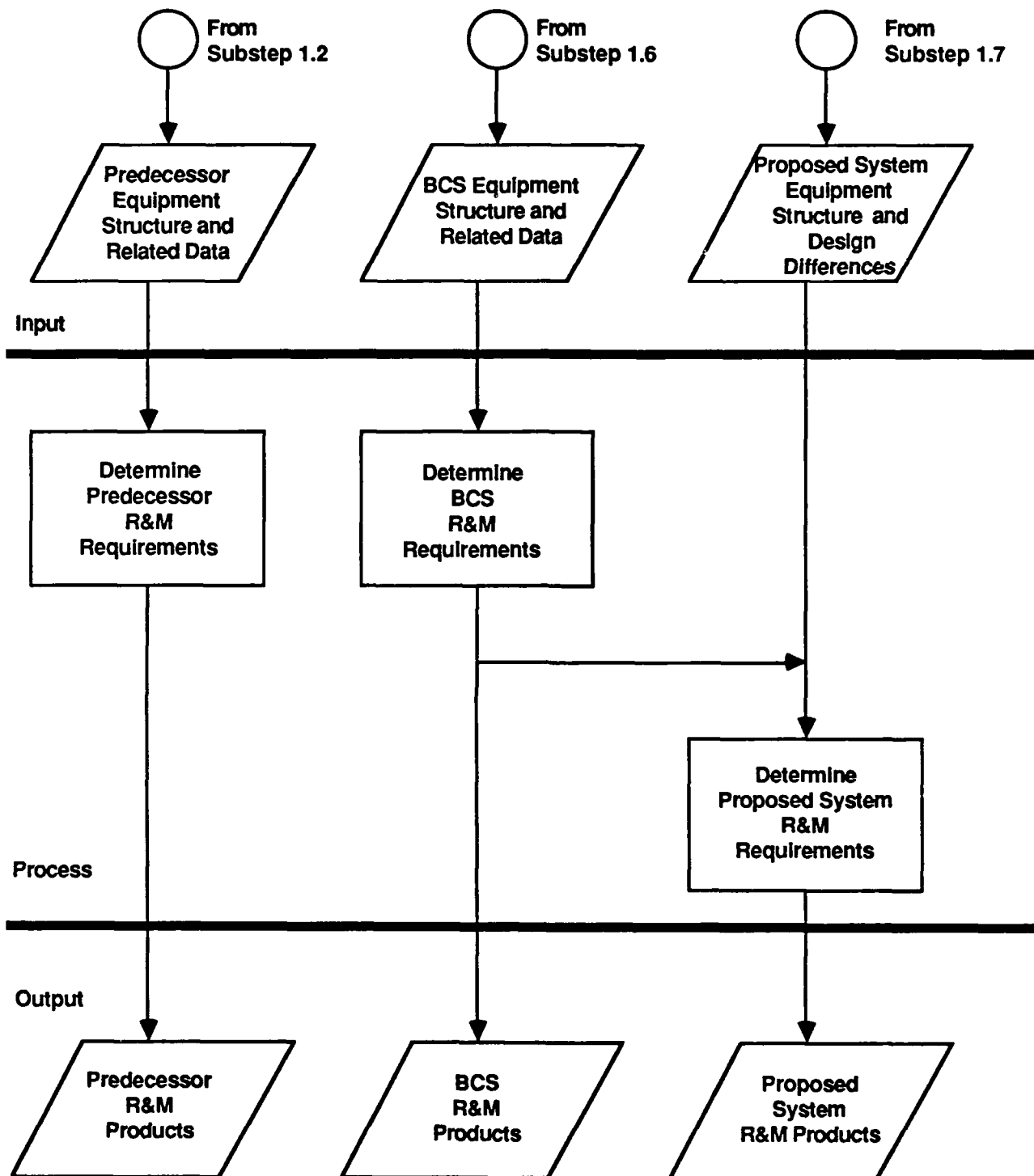


Figure 1.9-1. Overview of Substep 1.9, Determine R&M Requirements.

When a New System component is a conceptual design, the analyst must extrapolate the component's data from the BCS components. This extrapolation is based on the qualitative design differences between the BCS and New System that the analyst identifies in the Design Difference Index (DDI). The analyst converts the qualitative deficiencies to a quantitative adjustment factor and then applies this factor to the BCS component's data.

Action Step 1: Determine the Predecessor System's R&M Requirements

Discussion

In this action step the analyst assembles Predecessor System R&M data for each component and develops maintenance ratios.

NOTE

The analyst should be sure that the HCM analysis requires that Predecessor System manpower requirements be developed using R&M data. (Predecessor System manpower can be obtained from the MARC data base or the TOEs as described in Substep 2.3).

Procedures

1. Assemble and Evaluate R&M Data.

- For each component, obtain from an Army data-collection program the R&M data listed in Table 1.9-1. When possible, locate data sources that provide MRs by component.
- Determine whether the R&M data contain indirect maintenance time, for example, "make-ready" and "put-away" time. If the data contain indirect maintenance time, this maintenance time must be extracted.

NOTE

The extraction of indirect maintenance time will vary by data source. Appendix F provides methods that can be used to extract this maintenance time.

- Ensure that each component's related maintenance tasks (identified in Substep 1.8) have been considered in the development of CM and PM times.

Table 1.9-1. R&M Data Requirements

Minimum Requirements:

- Equipment usage rates
- Inherent failure rates (frequency of reliability-driven failures)
- Total Corrective Maintenance direct labor time
- Preventive Maintenance task time
- Preventive Maintenance task frequency
- Maintenance level performing the task
- Maintenance data for all maintenance levels

Preferred:

- Component's Mean [Metric] Between Maintenance Actions (M[M]BMA) for CM and PM at each maintenance level
- Component's Mean Time to Repair (MTTR) for CM and PM at each maintenance level
- Number of maintainers required for each component maintenance action at each maintenance level
- Component's MR by maintenance level for both CM and PM
- Associated maintenance data for all maintenance levels
- Associated MOS performing maintenance at each maintenance level

2. Develop a Maintenance Ratio for Each Component at Each Maintenance Level.

- If the data source provides MRs, record the component name, MR by maintenance level, and associated MOS on Worksheet 1.9-1 for each piece of equipment.
- If an MR is not available or is inaccessible, obtain or develop the following R&M data for each component by maintenance level:

M[M]BMA = Mean [Metric] Between
Maintenance Actions

MTTR = Mean Time to Repair

K = Number of People Required to Perform
the
Action

- Use the following formula to calculate an MR by maintenance level for each component:

$$\frac{1}{M[M]BMA} \times MTTR \times K = \frac{\text{Man-Hours}}{\text{Metric}} = MR$$

- Record the component MR by maintenance level on Worksheet 1.9-1. When the MOS or civilian skill type associated with each component and maintenance level is available, record it on the worksheet.

Procedure 1 Example

The New System is a utility helicopter. The analyst obtains the following Corrective Maintenance R&M data at the AVIM maintenance level for the Predecessor System's engine. The Mean Time Between Maintenance Actions (MTBMA) is expressed in operating hours and the Mean Time To Repair (MTTR) is expressed in maintenance hours.

	<u>Component</u>	<u>MTBMA</u>	<u>MTTR</u>	<u>Required Number of Maintainers</u>
Engine	Compressor Section	701.8	5.6	2
	Combustion Section	567.0	8.1	2
	Power Turbine Module	544.4	8.5	2
	Accessory Gearbox	929.3	11.8	2
	Fuel System	1,272.2	2.3	1
	Electrical System	1,180.0	2.9	1
	Oil System	673.6	1.1	1
	Air System	349.6	2.5	1

Procedure 2 Example

The analyst ensures that the data contain direct maintenance time only and that all component-related maintenance tasks were included. The analyst calculates CM MRs for each component:

<u>Component</u>			<u>Maintenance Ratio</u>
Engine			
Compressor Section	$\frac{1}{701.8}$	$\times 5.0 \times 2 =$	0.0160
Combustion Section	$\frac{1}{567.0}$	$\times 8.1 \times 2 =$	0.0286
Power Turbine Module	$\frac{1}{544.4}$	$\times 8.5 \times 2 =$	0.0312
Accessory Gearbox	$\frac{1}{929.3}$	$\times 11.8 \times 2 =$	0.0254
Fuel System	$\frac{1}{1,272.3}$	$\times 2.3 \times 1 =$	0.0018
Electrical	$\frac{1}{1,180.0}$	$\times 2.9 \times 1 =$	0.0025
Oil System	$\frac{1}{673.6}$	$\times 1.1 \times 1 =$	0.0016
Air System	$\frac{1}{349.6}$	$\times 2.5 \times 1 =$	0.0072

The analyst repeats these procedures for PM and for each applicable maintenance level.

Action Step 2: Determine the Baseline Comparison System's R&M Requirements

Discussion

In this action step the analyst assembles R&M data for each BCS component and develops MRs by maintenance level. Any component identified in Substep 1.6 (Determine BCS) is a component that possesses mature, historical R&M data.

Procedures

1. Assemble and Evaluate Data.

- Obtain each BCS component's R&M data from Substep 1.6. All BCS components in the BCS equipment structure have at least the minimum data requirements.
- Adjust the data to ensure that units of measure are consistent across data sources.
- Determine the level of analysis detail that the data will support. Because BCS R&M data sources can be different for each component, the data available to determine MRs will vary.
- Determine whether the BCS R&M data contain indirect maintenance time, for example, "make-ready" and "put-away" time. If the data do contain indirect maintenance time, this maintenance time must be extracted.

NOTE

The extraction of indirect maintenance time will vary by data source. Appendix F provides methods that can be used to extract this maintenance time.

- Ensure that each component's related maintenance tasks (identified in Substep 1.8) have been considered in the development of CM and PM times.

2. **Develop a Maintenance Ratio for Each Component at Each Maintenance Level.**

- If the data source provides MRs, record the BCS component name, MR by maintenance level, and associated MOS on Worksheet 1.9-2.
- If the MR is not available or is inaccessible, examine the required maintenance tasks associated with the BCS component and determine the responsible maintenance level. Or, use comparability analysis to determine the required maintenance level.

NOTE

The engineering analyst must be sure to work with the manpower and training analysts to determine the appropriate maintenance level for each task. This coordination ensures that the maintenance actions are distributed to the proper MOS and maintenance level.

- Distribute the R&M data to the appropriate maintenance level.
- Develop the following R&M data for each component by maintenance level:

M[M]BMA = Mean [Metric] Between
Maintenance Actions

MTTR = Mean Time to Repair

K = Number of People Required to Perform the
Action

- Use the following formula to calculate an MR by maintenance level for each component:

$$\frac{1}{M[M]BMA} \times MTTR \times K = \frac{\text{Man-Hours}}{\text{Metric}} = \text{MR}$$

- Record the BCS component, MR by maintenance level, and the associated MOS on Worksheet 1.9-2. When the MOS or civilian skill type associated with each BCS component and maintenance level is available, record it on the worksheet.

Procedure 1 Example

The analyst obtains the following Corrective Maintenance R&M data for a civilian helicopter engine that has been chosen as the BCS engine. The data presented in this example represent "shop" level maintenance, which is equivalent to AVIM. The analyst has also received "on site" and "overhaul" maintenance data, which are equivalent to AVUM and Depot respectively (these data are not shown in the example).

In this example, only the CM portion of the MR is derived. The analyst would repeat these procedures to determine Preventive Maintenance MRs.

<u>Component</u>	<u>Average Incidents Per Month</u>	<u>Average Usage Rate (In Hours) Per Month</u>	<u>Average Monthly Maintenance Time (In Hours) Charged to Component</u>	<u>Number of Maintainers</u>
Compressor	5.29	4.600	43.86	2
Gas Generator	7.89	4.600	33.67	2
Turbine	4.93	4.600	35.46	2
Gearbox	3.07	4.600	106.73	2
Fuel System	3.41	4.600	16.81	1
Electrical System	5.29	4.600	23.99	1
Oil System	4.99	4.600	14.64	1
Air System	2.89	4.600	9.54	1

The analyst adjusts the units of measure to a yearly measure by multiplying the values listed above, except the number of maintainers, by 12.

(continued)

Procedure 1 Example (continued)

<u>Component</u>	<u>Average Incidents Per Year</u>	<u>Average Usage Rate (In Hours) Per Year</u>	<u>Average Yearly Maintenance Time (In Hours) Charged to Component</u>	<u>Number of Maintainers</u>
Compressor	63.5	55.200	526.3	2
Gas Generator	94.7	55.200	404.0	2
Turbine	59.1	55.200	425.5	2
Gearbox	36.8	55.200	1280.7	2
Fuel System	40.9	55.200	201.7	1
Electrical System	63.5	55.200	287.9	1
Oil System	59.9	55.200	175.7	1
Air System	35.8	55.200	114.5	1

Procedure 2 Example

The analyst checks the data and discovers that the data include indirect maintenance time. The analyst consults the data source and determines that the engine repair shop has an indirect maintenance time factor of 25 percent. The analyst removes the indirect maintenance time by extracting 25 percent of the total maintenance time.

	<u>Average Yearly Maintenance Time (In Hours) Charged To Component</u>	<u>Adjusted Average Maintenance Time (In Hours) Charged to Component</u>
Compressor	526.3	394.7
Gas Generator	404.0	303.0
Turbine	425.5	319.1
Gearbox	1280.7	960.5
Fuel System	201.7	151.3
Electrical System	287.9	215.9
Oil System	175.7	131.8
Air System	114.5	85.9

(continued)

Procedure 2 Example (continued)

The analyst first calculates the CM Mean Time Between Maintenance Actions (MTBMA) for each component by dividing the total flight hours by the number of repair incidents.

<u>Component</u>		<u>MTBMA</u>
Compressor	$\frac{55,200}{63.5} =$	869.3
Gas Generator	$\frac{55,200}{94.7} =$	582.9
Turbine	$\frac{55,200}{59.1} =$	934.0
Gearbox	$\frac{55,200}{110.4} =$	500.0
Fuel System	$\frac{55,200}{40.9} =$	1349.6
Electrical System	$\frac{55,200}{63.5} =$	869.3
Oil System	$\frac{55,200}{59.9} =$	921.5
Air System	$\frac{55,200}{35.8} =$	1541.9

Next the analyst determines the CM Mean Time to Repair (MTTR) for each component by dividing the total repair time by the number of repair incidents.

<u>Component</u>		<u>MTTR</u>
Compressor	$\frac{394.7}{63.5} =$	6.2
Gas Generator	$\frac{303.0}{94.7} =$	3.2
Turbine	$\frac{319.1}{59.1} =$	5.4
Gearbox	$\frac{960.5}{110.4} =$	8.7
Fuel System	$\frac{151.3}{40.9} =$	3.7

(continued)

Procedure 2 Examples (continued)

Electrical System	$\frac{215.9}{63.5} =$	3.4
Oil System	$\frac{131.8}{59.9} =$	2.2
Air System	$\frac{85.9}{35.8} =$	2.4

The analyst uses the MTBMA, MTTR, and number of maintainers, to calculate an MR for each component.

<u>Component</u>		<u>MR</u>
Compressor	$\frac{1}{869.3} \times 6.2 \times 2 =$	0.0143
Gas Generator	$\frac{1}{582.9} \times 3.2 \times 2 =$	0.0110
Turbine	$\frac{1}{934.0} \times 5.4 \times 2 =$	0.0116
Gearbox	$\frac{1}{500.0} \times 8.7 \times 2 =$	0.0348
Fuel System	$\frac{1}{1349.6} \times 3.7 \times 1 =$	0.0027
Electrical System	$\frac{1}{869.3} \times 3.4 \times 1 =$	0.0039
Oil System	$\frac{1}{921.5} \times 2.2 \times 1 =$	0.0024
Air System	$\frac{1}{1541.9} \times 2.4 \times 1 =$	0.0016

The analyst repeats these procedures for each applicable maintenance level.

Action Step 3: Determine the Proposed System's R&M Requirements

Discussion

In this action step the analyst assembles R&M data for actual components and projects R&M data for conceptual components (i.e., New System component requirements for which an actual component/design does not exist). From these R&M data, the analyst develops MRs for each component at each maintenance level.

The analyst determines actual component data in the same manner as for the Predecessor System and BCS. Conceptual component data, however, are extrapolated from BCS component data. This data projection is based on the design differences between the BCS component functional characteristics and New System functional requirements.

The analyst quantifies design differences in the form of Reliability-Centered Adjustment Factors (RCAFs) and Maintainability-Centered Adjustment Factors (MCAFs). An RCAF reflects differences in reliability; an MCAF reflects differences in maintainability. Adjustment factors are expressed as a percentage increase or decrease in component reliability or maintainability. These factors are applied directly to BCS data values to project the conceptual component's R&M data.

Procedures

1. **Assemble and Evaluate Actual Proposed System Component Data.**
 - Obtain component R&M data from the data sources identified in Substep 1.7.
 - Adjust the data to coincide with the units of measure established for the BCS and Predecessor System components.
 - Determine the level of analysis detail that the Proposed System component data will support for actual components. When actual components do not exist, use the level of detail found in the BCS.
 - Determine whether the actual component/design R&M data contain indirect maintenance time, for example, "make-ready" and "put-away" time. If the data contain indirect maintenance time, this maintenance time must be extracted.

NOTE

The extraction of indirect maintenance time will vary by data source. Appendix F provides methods that can be used to extract this maintenance time.

- Ensure that each component's related maintenance tasks (identified in Substep 1.8) have been considered in the development of CM and PM times.
2. **Develop a Maintenance Ratio for Each Actual Proposed System Component at Each Maintenance Level.**
- If the data source provides MRs, record the component name, MR by maintenance level, and associated MOS on Worksheet 1.9-3.
 - If the MR is not available or is inaccessible, examine the required maintenance tasks associated with the component and determine the required maintenance level.
 - Distribute the R&M data to the appropriate maintenance level.
 - Develop the following R&M parameters for each component by maintenance level:

$M[M]BMA$ = Mean [Metric] Between Maintenance Actions
 $MTTR$ = Mean Time to Repair
 K = Number of People Required to Perform the Action
 - Use the following formula to calculate an MR by maintenance level for each component:
$$\frac{1}{M[M]BMA} \times MTTR \times K = \frac{\text{Man-Hours}}{\text{Metric}} = MR$$
 - Record the Proposed System component name, MR by maintenance level, and the associated MOS on Worksheet 1.9-3. When the MOS or required skill type associated with each component and maintenance level is available, record it on the worksheet.
3. **Develop BCS-to-New System R&M Adjustment Factors for Each Conceptual Proposed System Component.**
- Obtain the BCS-to-New System design differences for each conceptual Proposed System component from the Design Difference Index (DDI) on Worksheet 1.7-2.

-
- Evaluate the BCS component's reliability-centered design differences and determine the Reliability-Centered Adjustment Factor (RCAF). Each RCAF is predicated on the specific nature of the design differences. Exercise professional judgment to determine the RCAF's magnitude and direction. Consult subject-matter experts (SMEs) to obtain their opinions about the RCAF.

NOTE

As a general rule, RCAFs of 10 percent or less represent low-risk improvements; 11 to 30 percent, medium risk; and over 30 percent, high risk. The more risk involved, the more attention the analyst should devote to securing a consensus from SMEs who are not involved in the HCM analysis.

- Use the following equation to apply an RCAF to each BCS component's M[M]BMA at each maintenance level:

$$M[M]BMA \times (1 + RCAF) = \text{Adjusted } M[M]BMA$$

Where:

M[M]BMA = Mean [Metric] Between
Maintenance Actions

RCAF = Reliability-Centered Adjustment Factor

NOTE

An increase in reliability would produce a positive RCAF (fewer maintenance actions required). A decrease in reliability would produce a negative RCAF.

- Record each component, RCAF, and adjusted M[M]BMA on Worksheet 1.9-4.
- Evaluate each BCS component's maintainability-centered design differences and determine the Maintainability-Centered Adjustment Factor (MCAF). Each MCAF is predicated on the specific nature of the design differences that affect the required maintenance, required tasks, task duration, additional requirements, maintenance concept, etc. Exercise professional judgment to determine the MCAF's magnitude and direction and seek SMEs' opinions and assistance.
- Use the following formula to apply an MCAF to the MTTR of each BCS component at each maintenance level:

$$MTTR \times (1 + MCAF) = \text{Adjusted MTTR}$$

Where:

MTTR = Mean Time To Repair

MCAF = Maintainability-Centered Adjustment Factor

NOTE

An increase in maintainability requirements would produce a positive MCAF. A decrease in maintainability requirements would produce a negative MCAF.

- Record each component, MCAF, and the adjusted MTTR on Worksheet 1.9-3
 - Examine the number of soldiers required to perform each New System component's maintenance tasks. Adjust the number of soldiers (K in the maintenance-ratio equation) if this number differs from the BCS requirements.
4. Calculate an MR by Maintenance Level for Each Conceptual Proposed System Component.
- Use the following equation to calculate an MR for each component by maintenance level:

$$\frac{1}{AM[M]BMA} \times AMTTR \times AK = MR$$

Where:

MR = Maintenance Ratio

AM[M]BMA = Adjusted Mean [Metric] Between Maintenance Actions

AMTTR = Adjusted Mean Time to Repair

AK = Adjusted Number of People Required to Perform the Action

- Record each component's MR on Worksheet 1.9-3.

Procedure 1 and 2 Example

The utility helicopter engine example is continued here. Two contractors have proposed engines that meet the New System's performance requirements. Each contractor has provided the required component R&M data. Company A is proposing its P200 engine. This engine is currently in the developmental-testing phase, so engineering estimates and lab test data are available. Company B is proposing its G340 engine. This engine has recently been installed in several prototype aircraft, so engineering estimates and actual test data are available.

Company A has provided the following yearly AVIM Corrective Maintenance MRs for each component:

<u>Component</u>	<u>MR</u>
Compressor	0.0110
Combustion Chamber	0.0150
Turbine	0.0100
Gearbox	0.0190
Fuel System	0.0020
Electrical System	0.0020
Lubricating System	0.0020
Air System	0.0020

The analyst checks the data to be certain that the data contain direct maintenance time only and that all component-related maintenance tasks were included.

Procedure 1 and 3 Examples

The New System specifications require a rotor subsystem made of flexible composites that will significantly reduce the number of moving parts in the rotor assembly. Because this concept is experimental, the analyst must extrapolate the rotor subsystem's R&M data from the BCS data.

The BCS rotor subsystem data shown below represent direct Corrective Maintenance time (hours) at the AVIM maintenance level.

<u>Component</u>	<u>MTBMA</u>	<u>MTTR</u>	<u>Required Number of Maintainers</u>
Main Rotor Hub	450.1	3.1	2
Main Rotor Damper	401.2	3.0	2
Main Rotor Scissors	525.4	2.5	1
Main Rotor Spindle	358.2	8.3	2
Main Rotor Pressure Plate	289.9	2.1	2
Main Rotor Swashplate	211.2	11.4	2
Main Rotor Blade	524.3	2.5	4

The analyst examines each BCS component's design differences and consults SMEs to determine the appropriate Reliability-Centered Adjustment Factor (RCAF). The analyst then applies the RCAF to obtain each component's adjusted MTBMA.

(continued)

Procedure 1 and 3 Examples (continued)

<u>Component</u>		<u>Adjusted MTBMA</u>	<u>Explanation</u>
Main Rotor Hub	$450.1 \times (1 + .5) =$	675.2	Increased reliability
Main Rotor Damper	$401.2 \times (1 + .2) =$	481.4	Increased reliability
Main Rotor Scissors	Not Applicable		
Main Rotor Spindle	$358.2 \times (1 + .2) =$	429.8	Increased reliability
Main Rotor Pressure Plate	$289.9 \times (1 + 0) =$	289.9	No change
Main Rotor Swashplate	$211.2 \times (1 + .5) =$	316.8	Increased reliability
Main Rotor Blades	$524.3 \times (1 + (-.2)) =$	419.4	Decreased reliability

The analyst examines each BCS component's design differences and maintenance requirements and consults SMEs to determine the appropriate Maintainability-Centered Adjustment Factor (MCAF). The analyst then applies the MCAF to obtain each component's adjusted MTTR.

<u>Component</u>		<u>Adjusted MTTR</u>	<u>Explanation</u>
Main Rotor Hub	$3.1 \times (1 + .3) =$	4.0	Increased maintenance time
Main Rotor Damper	$3.0 \times (1 + (-.1)) =$	2.7	Decreased maintenance tasks
Main Rotor Scissors	Not Applicable		
Main Rotor	$8.3 \times (1 + (-.2)) =$	6.6	Decreased maintenance requirements

(continued)

Procedure 1 and 3 Examples (continued)

<u>Component</u>		<u>Adjusted MTTR</u>	<u>Explanation</u>
Main Rotor Pressure Plate	$2.1 \times (1 + 0) =$	2.1	No change
Main Rotor Swashplate	$11.4 (1 + (-.7)) =$	3.4	Decreased maintenance tasks/time
Main Rotor Blade	$2.5 (1 + .3) =$	3.3	Increased maintenance time

The analyst also makes adjustments to the required number of maintainers, if necessary. No changes are required in this example.

Procedure 4 Example

The analyst calculates each conceptual component's MR:

<u>Component</u>		<u>MR</u>
Main Rotor Hub	$\frac{1}{675.2} \times 4.0 \times 2 =$	0.0118
Main Rotor Damper	$\frac{1}{481.4} \times 2.7 \times 2 =$	0.0112
Main Rotor Scissors	Not Applicable	
Main Rotor Spindle	$\frac{1}{429.8} \times 6.6 \times 2 =$	0.0308
Main Rotor Pressure Plate	$\frac{1}{289.9} \times 2.1 \times 2 =$	0.0145
Main Rotor Swashplate	$\frac{1}{316.8} \times 3.4 \times 2 =$	0.0215
Main Rotor Blades	$\frac{1}{419.4} \times 3.3 \times 4 =$	0.0315

The analyst repeats these procedures for each maintenance level and for Preventive Maintenance activities.

**SUBSTEP 1.9
WORKSHEETS**

WORKSHEET 1.9-1

Use this worksheet to document the maintenance ratios of each Predecessor System component by maintenance level.

Predecessor Component	Maintenance Ratios			Associated MOSS
	Org	DS	GS		Depot

WORKSHEET 1.9-2

Use this worksheet to document BCS component maintenance ratios.

Component	MAINTENANCE RATIOS				Associated MOSSs
	Org	DS	GS	Depot	

WORKSHEET 1.9-3

Use this worksheet to document Proposed System component maintenance ratios.

Component	Maintenance Ratios				Associated MOSS
	Org	DS	GS	Depot	

WORKSHEET 1.9-4

Use this worksheet to document conceptual Proposed System component adjustment factors.

Component	RCAF	Adjusted M [M] BMA			
		Org	DS	GS	Depot

WORKSHEET 1.9-5

Use this worksheet to document Conceptual Proposed System Component Adjustment Factors.

Component	MCAF	Adjusted M [M] BA			
		Org	DS	GS	Depot

APPENDIX A: OPERATIONAL-FUNCTION LIST BY SYSTEM TYPE ¹

The following pages contain lists of operational functions by system type. The table below lists the page number for each system type:

<u>Table Number and System Type</u>	<u>Appendix Page</u>
1 - Infantry Fighting Vehicles, Cavalry Fighting Vehicles, Anti-Tank Vehicles, and Tanks	A-3
2 - Medium-Range Missile Artillery Systems	A-5
3 - Towed Howitzers	A-7
4 - Self-propelled Howitzers	A-9
5 - Air Defense - Mobile Gun Systems	A-12
6 - Attack Helicopters	A-15
7 - Cargo Helicopters	A-17
8 - Utility Helicopters	A-20
9 - Scout Helicopters	A-23
10 - Light and Heavy Cargo Transport Trucks	A-25
11 - Grenade Launchers	A-26
12 - Man-Portable Air Defense Systems	A-27
13 - Man-Portable Anti-Tank Weapons	A-28
14 - Man-Portable Indirect Fire Infantry Weapons (Mortars)	A-29
15 - Automatic Weapons	A-30
16 - Rifles	A-31

¹ * These function tables were extracted from "Product 1: System Performance Requirements Estimation Aid (Final)." S. Dahl, R. Laughery, and R. Archer. Army Research Institute, Alexandria, VA: Micro Analysis and Design and Dynamics Research Corporation, 1987.

On each table the functions are in capital letters. Beneath most of these functions is a list of related subfunctions, for example:

1. PLAN AND PREPARE MISSION

- Receive/Review Order
- Adjust/Boresight Weapon System
- Adjust/Inspect Other Systems
- Enter Data onto Onboard Computers
- Prepare for NBC Environment

**TABLE 1 - OPERATIONAL FUNCTIONS FOR INFANTRY
FIGHTING VEHICLES, CAVALRY FIGHTING VEHICLES, ANTI-TANK
VEHICLES, & TANKS**

1. **PLAN AND PREPARE MISSION**
 - Receive/Review Order
 - Adjust/Boresight Weapon System
 - Adjust/Inspect Other Systems
 - Enter Data to Onboard Computers
 - Prepare for NBC Environment
2. **EXECUTE MOVEMENT**
 - Start Engine
 - Check Controls/Instruments
 - Perform Non-Tactical Movement
 - Perform Tactical Movement
 - Perform Water Crossing
3. **EXECUTE MANEUVER**
 - Perform Evasive Maneuvers
 - Move to Cover
 - Negotiate Obstacles
 - Employ Smoke Screen
 - Move Into Firing Position
 - Move Out of Firing Position
4. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
 - Identify Terrain Features
 - Use Instruments (i.e., Compass) to Select Correct Heading
5. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Use Countermeasure Procedures
 - Relay Messages
 - Obtain Line of Signal

**TABLE 1 - OPERATIONAL FUNCTIONS FOR INFANTRY
FIGHTING VEHICLES, CAVALRY FIGHTING VEHICLES, ANTI-TANK
VEHICLES, & TANKS (continued)**

6. **ACQUIRE TARGETS**
 - Search for Targets
 - Detect/Locate Targets
 - Identify Friend or Foe
 - Identify/Locate Sources of Enemy Fire
7. **ENGAGE TARGETS**
 - Select Target(s)
 - Select Weapon and Ammo
 - Aim/Sight Weapon
 - Track Target
 - Fire Weapon
 - Adjust Fire
 - Assess Damage
8. **OCCUPY DEFENSIVE POSITION**
 - Select Position
 - Camouflage Position
 - Improve Cover
 - Select Reference Points
 - Develop Range Cards
 - Coordinate with Adjacent Vehicles/Personnel
9. **CALL FOR/ADJUST SUPPORTING FIRE**
 - Call For/Adjust Artillery/Mortar Fire
 - Call For/Adjust Aerial Fire
 - Adjust Tank/Other Fighting Vehicle Fire
10. **TRANSPORT COMBAT TROOPS**
 - Load Troops/Equipment
 - Secure Troops/Equipment
 - Unload Troops/Equipment
11. **COMPENSATE FOR EQUIPMENT MALFUNCTIONS & EMERGENCIES**
 - Identify Malfunction
 - Identify Source of Malfunction
 - Compensate for Malfunction/Execute Emergency Procedures
 - Evacuate Vehicle (if appropriate)
12. **PERFORM POST-OPERATION TASKS**
 - Shut Down Engine
 - Power Down Other Systems
 - Perform Checks

**TABLE 2 - OPERATIONAL FUNCTIONS FOR MEDIUM-RANGE
MISSILE ARTILLERY SYSTEMS
(Assumes Missile is on Self-propelled Launcher)**

- 1. FOR MARCH ORDER**
 - Receive March Order
 - Receive Weapon from Assembly and Transport Section
 - Prepare Self-propelled Launcher (SPL) for Movement
 - Ensure Firing Point Is Surveyed
- 2. MOVE TO FIRING POINT**
 - Start Engine
 - Perform Pre-Operational Vehicle Check
 - Drive SPL
- 3. NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
- 4. COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
- 5. EMPLACE SYSTEM**
 - Position SPL Over Launch Stake
 - Shut Down Vehicle
 - Prepare Vehicle for Firing Mode
 - Inspect Main Missile Assembly (MMA) and Warhead Section (WHS) for Damage
 - Release Tie Down Straps, Release Traverse, and Lockpins
- 6. PREPARE WEAPON FOR FIRING**
 - Receive Firing Data
 - Turn On Monitor-Programmer
 - Conduct Self Test
 - Lay/Sight Weapon
 - Remove Protective Covers

**TABLE 2 - OPERATIONAL FUNCTIONS FOR MEDIUM-RANGE
MISSILE ARTILLERY SYSTEMS
(Assumes Missile is on Self-propelled Launcher) (continued)**

- 7. FIRE WEAPON**
 - Arm WHS
 - Insert WHS Settings
 - Move Firing Device to Firing Pit
 - Elevate Missile
 - Place Selector in Launch Position
 - Clear Area
 - Fire Missile
- 8. CONDUCT POST-FIRING INSPECTIONS**
- 9. EXECUTE FAILURE-TO-FIRE PROCEDURES**
 - Lower Launcher
 - Safe the WHS
 - Disconnect Firing Device
 - Reorient Launcher
 - Obtain New Orientation from Remote Theodolite
- 10. COMPENSATE FOR EQUIPMENT MALFUNCTIONS AND EMERGENCIES**
 - Identify Malfunction
 - Identify Source of Malfunction
 - Compensate for/Recover from Malfunction
- 11. PERFORM EMERGENCY DESTRUCTION OF WARHEAD**
 - Insert Command Disablement Code
 - Set Shape Charge to Warhead
 - Evacuate Area
 - Destroy Warhead
 - Verify Destruction
- 12. DISPLACE SYSTEM**
 - Secure Launcher
 - Leave Position

TABLE 3 - OPERATIONAL FUNCTIONS FOR TOWED HOWITZERS

1. **PREPARE FOR MARCH ORDER**
 - Receive March Order
 - Perform Pre-Operational Checks
 - Perform Fire-Control Alignment
 - Test Gunner's Quadrants
2. **DRIVE/MOVE CANNON**
 - Drive Vehicle (Non-Tactical March)
 - Conduct Tactical March
 - Perform Water Crossing
3. **EMPLACE CANNON**
 - Uncouple Cannon from Vehicle
 - Select Position
 - Prepare Position
 - Emplace/Align Collimator
 - Emplace/Align Aiming Posts
4. **DISPLACE CANNON**
 - Recover Collimator
 - Recover Aiming Posts
 - Uncouple Cannon
 - Leave Position
5. **PREPARE CANNON FOR FIRING**
 - Set Up Aiming Circle
 - Establish Azimuth of the Orienting Line
 - Lay Weapon
 - Establish Aiming Points
 - Determine Site to Crest
 - Boresight Weapon/Telescopes
 - Emplace Azimuth Markers
 - Perform Pre-fire Checks
 - Prepare Range Card
6. **FIRE CANNON**
 - Receive Firing Order
 - Prepare Ammunition for Firing
 - Set Elevation and Deflection
 - Load Cannon
 - Fire Cannon
 - Unload Cannon

**TABLE 3 - OPERATIONAL FUNCTIONS FOR TOWED HOWITZERS
(continued)**

7. FIRE CANNON AT DIRECT FIRE TARGETS
 - Identify Target(s)
 - Select Target
 - Determine Target Range
 - Determine Target Lead
 - Select Ammunition
 - Load Ammunition
 - Aim/Sight Weapon
 - Fire
 - Unload Cannon
8. NAVIGATE
 - Identify Present Location
 - Identify Destination
 - Plot Travel Route
 - Estimate Time of Arrival and Travel Requirements
9. COMMUNICATE
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
10. DEFEND AGAINST ATTACK
 - Deploy to Cover
 - Evade Threat
11. COMPENSATE FOR EQUIPMENT MALFUNCTIONS AND EMERGENCIES
 - Clear Misfire on Cannon
12. CONDUCT POST-MISSION TASKS
 - Complete Forms
 - Perform Post-Operation Checks

TABLE 4 - OPERATIONAL FUNCTIONS FOR SELF-PROPELLED HOWITZERS

- 1. PREPARE FOR MARCH ORDER**
 - Receive March Order
 - Perform Pre-Operation Checks
 - Perform Fire-Control Alignment
 - Test Gunner's Quadrants
 - Prepare Vehicle/Personnel for NBC environment
- 2. DRIVE/MOVE CANNON**
 - Drive Vehicle
 - Conduct Tactical March
 - Perform Water Crossing
- 3. EMPLACE CANNON**
 - Select Position
 - Prepare Position
 - Emplace/Align Collimator
 - Emplace/Align Aiming Posts
- 4. DISPLACE CANNON**
 - Recover Collimator
 - Recover Aiming Posts
 - Leave Position
- 5. PREPARE CANNON FOR FIRING**
 - Set Up Aiming Circle
 - Establish Azimuth of the Orienting Line
 - Lay Weapon
 - Establish Aiming Points
 - Determine Site to Crest
 - Boresight Weapon/Telescopes
 - Emplace Azimuth Markers
 - Perform Pre-fire Checks
 - Prepare Range Card
- 6. FIRE CANNON**
 - Receive Firing Order
 - Prepare Ammunition for Firing
 - Set Elevation and Deflection
 - Load Cannon
 - Fire Cannon
 - Unload Cannon

**TABLE 4 - OPERATIONAL FUNCTIONS FOR SELF-PROPELLED
HOWITZERS (continued)**

7. **FIRE CANNON AT DIRECT FIRE TARGETS**
 - Identify Target(s)
 - Select Target
 - Determine Target Range
 - Determine Target Lead
 - Select Ammunition
 - Load Ammunition
 - Aim/Sight Weapon
 - Fire
 - Unload Cannon
8. **FIRE CREW-SERVED WEAPONS**
 - Load Ammunition
 - Identify Target(s)
 - Select Target
 - Determine Target Range
 - Aim/Sight Weapon
 - Fire Weapon
 - Adjust Fire
 - Unload Weapon
9. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Plot Travel Route
 - Estimate Time of Arrival and Travel Requirements
10. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
11. **DEFEND AGAINST ATTACK**
 - Deploy to Cover
 - Evade Threat

**TABLE 4 - OPERATIONAL FUNCTIONS FOR SELF-PROPELLED
HOWITZERS (continued)**

12. COMPENSATE FOR EQUIPMENT MALFUNCTIONS AND EMERGENCIES

- Identify Malfunction
- Identify Source of Malfunction
- Compensate/Recover from Malfunction
- Evacuate Vehicle
- Extinguish Fire
- Clear Misfire on Crew-Served Weapon
- Clear Misfire on Cannon

13. CONDUCT POST-MISSION TASKS

- Complete Forms
- Perform Post-Operation Checks

**TABLE 5 - OPERATIONAL FUNCTIONS FOR AIR DEFENSE - MOBILE
GUN SYSTEM
(For Self-propelled Vehicle Only)**

- 1. PREPARE FOR MARCH ORDER**
 - Receive March Order
 - Prepare Weapon System for Travel
 - Performs Pre-Operation Vehicle Checks
 - Prepare Vehicle/Personnel for NBC Environment
- 2. MOVE VEHICLE**
 - Start/Stop Engine
 - Couple Weapon to Vehicle
 - Drive Vehicle
 - Perform Tactical Movement
 - Perform Water Crossing
- 3. EMPLACE SYSTEM**
 - Select Position
 - Move Vehicle Onto Position
 - Camouflage Vehicle
- 4. PREPARE WEAPON FOR ENGAGEMENT**
 - Designate Observation and Command Posts' Primary Target Lines and Sectors of Search
 - Establish Observation and Command Posts
 - Emplace/Start Auxiliary Power Unit
 - Perform Pre-fire Checks
 - Determine Aiming Points
 - Emplace Target Alert System
 - Boresight Weapon
- 5. LOAD/RELOAD WEAPON**
 - Prepare Ammunition
 - Prepare Weapon for Firing
 - Load Ammunition
- 6. ACQUIRE TARGET**
 - Search for Target
 - Detect/Locate Target
 - Identify Friend or Foe

**TABLE 5 - OPERATIONAL FUNCTIONS FOR AIR DEFENSE - MOBILE
GUN SYSTEM
(For Self-propelled Vehicle Only) (continued)**

7. ENGAGE AIRCRAFT TARGETS
 - Select Target
 - Determine Target Speed and Range
 - Aim/Sight Weapon
 - Track Target
 - Fire Weapon
 - Adjust Fire
 - Reset Target Alert System
8. ENGAGE GROUND TARGETS
 - Select Target
 - Determine Target Range
 - Aim/Sight Weapon
 - Fire Weapon
 - Adjust Fire
9. NAVIGATE
 - Identify Present Location
 - Identify Destination
 - Plot Travel Route
 - Estimate Time of Arrival and Fuel Requirements
10. COMMUNICATE
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
11. DEFEND AGAINST ATTACK
 - Deploy to Cover
 - Evade Threat
12. DISPLACE SYSTEM
 - Remove APU
 - Disconnect/Remove Target Alert System
 - Leave Position
13. PERFORM POST-MISSION TASKS
 - Perform Post-Operation Checks

**TABLE 5 - OPERATIONAL FUNCTIONS FOR AIR DEFENSE - MOBILE
GUN SYSTEM
(For Self-propelled Vehicle Only) (continued)**

14. COMPENSATE FOR EQUIPMENT MALFUNCTIONS AND EMERGENCIES

- Identify Malfunction
- Identify Source of Malfunction
- Compensate/Recover from Malfunction
- Evacuate Vehicle
- Extinguish Fires

TABLE 6 - OPERATIONAL FUNCTIONS FOR ATTACK HELICOPTERS

1. **PLAN AND PREPARE FOR MISSION**
 - Plan Flight
 - Check Load
 - Calculate Weight and Balance Bearing
 - Prepare Performance Planning Card
 - Enter Pre-flight Data
 - Conduct Preflight Inspection
 - Perform Engine Start, Run-Up, and Before-Takeoff Checks
 - Prepare Vehicle/Personnel for NBC Environment
2. **TAXI AND TAKEOFF**
 - Perform Ground Taxi
 - Perform Hover Power Check
 - Perform Hovering Flight
 - Perform Takeoff
3. **FLY AIRCRAFT TO/FROM MISSION AREA**
 - Cruise (Non-Tactical Flight)
 - Perform Tactical Flight
 - Monitor Instruments
 - Perform Holding Procedure
4. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
5. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
6. **APPROACH AND LAND AIRCRAFT**
 - Perform Before-Landing Checks
 - Approach
 - Land
 - Taxi
7. **PERFORM AFTER-LANDING TASKS**
 - Conduct Engine Shutdown
 - Conduct Post-Flight Checks
 - Complete Reports and Forms
 - Conduct Briefing

**TABLE 6 - OPERATIONAL FUNCTIONS FOR ATTACK
HELICOPTERS (continued)**

8. COMPENSATE FOR INFLIGHT EQUIPMENT MALFUNCTIONS AND EMERGENCIES
 - Identify Malfunction
 - Identify Source of Malfunction
 - Compensate/Recover from Malfunction
 - Extinguish Fire
 - Clear Weapon Misfire
 - Evacuate Aircraft
9. ACQUIRE TARGETS
 - Detect/Locate Targets
 - Identify Friend or Foe
10. ATTACK TARGET
 - Maneuver for Attack
 - Select Target(s)
 - Select Weapon
 - Aim/Sight Weapon
 - Track Target
 - Fire Weapon
 - Adjust Fire
 - Egress From Attack Position
11. DEFEND AGAINST ATTACK
 - Deploy to Cover
 - Identify/Locate Source of Threat/Fire
 - Identify/Locate Threat Target Tracking
 - Perform Evasive Maneuvers
 - Employ ECCM
 - Dispense/Disperse Smoke
12. PERFORM RECONNAISSANCE
 - Move to Recon Area
 - Obtain Tactical Information
13. CALL FOR DIRECT SUPPORT
 - Call For and Adjust Indirect Fire
 - Request/Adjust Illumination

TABLE 7 - OPERATIONAL FUNCTIONS FOR CARGO HELICOPTERS

1. **PLAN AND PREPARE FOR MISSION**
 - Plan Flight
 - Check Load
 - Calculate Weight and Balance Bearing
 - Prepare Performance Planning Card
 - Enter Pre-flight Data
 - Conduct Pre-flight Inspection
 - Perform Engine Start, Run-Up, and Before-Takeoff Checks
 - Prepare Vehicle/Personnel For NBC Environment
2. **TAXI AND TAKEOFF**
 - Perform Ground Taxi
 - Perform Hover Power Check
 - Perform Hovering Flight
 - Perform Takeoff
3. **FLY AIRCRAFT TO/FROM MISSION AREA**
 - Cruise (Non-Tactical Flight)
 - Perform Tactical Flight
 - Monitor Instruments
 - Perform Holding Procedure
4. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
5. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
6. **APPROACH AND LAND AIRCRAFT**
 - Perform Before-Landing Checks
 - Approach
 - Land
 - Taxi

**TABLE 7 - OPERATIONAL FUNCTIONS FOR CARGO
HELICOPTERS (continued)**

7. PERFORM AFTER-LANDING TASKS

- Conduct Engine Shutdown
- Conduct Post-Flight Checks
- Complete Reports and Forms
- Conduct Briefing

**8. COMPENSATE FOR INFLIGHT EQUIPMENT MALFUNCTIONS AND
EMERGENCIES**

- Identify Malfunction
- Identify Source of Malfunction
- Compensate/Recover from Malfunction
- Extinguish Fire
- Clear Weapon Misfire
- Evacuate Aircraft

9. ACQUIRE TARGETS

- Detect/Locate Targets
- Identify Friend or Foe

10. ATTACK TARGET

- Maneuver for Attack
- Select Target(s)
- Select Weapon
- Aim/Sight Weapon
- Track Target
- Fire Weapon
- Adjust Fire
- Egress from Attack Position

11. DEFEND AGAINST ATTACK

- Deploy to Cover
- Identify/Locate Source of Threat/Fire
- Identify/Locate Threat Target Tracking
- Perform Evasive Maneuvers
- Employ ECCM
- Dispense/Disperse Smoke

12. LOAD/UNLOAD INTERNAL LOADS

- Brief Passengers
- Load Passengers/Cargo
- Unload Passengers/Cargo

**TABLE 7 - OPERATIONAL FUNCTIONS FOR CARGO
HELICOPTERS (continued)**

13. RAISE/LOWER EXTERNAL LOADS

- Attach Load
- Raise Load
- Lower Load

14. PERFORM PARADROP

15. RAPPEL TROOPS

16. PERFORM RECONNAISSANCE

- Move to Recon Area
- Obtain Tactical Information
- Transmit Tactical Report

17. CALL FOR DIRECT SUPPORT

- Call For and Adjust Indirect Fire
- Request/Adjust Illumination
- Adjust Attack Helicopter Fire

TABLE 8 - OPERATIONAL FUNCTIONS FOR UTILITY HELICOPTERS

1. **PLAN AND PREPARE FOR MISSION**
 - Plan Flight
 - Check Load
 - Calculate Weight and Balance Bearing
 - Prepare Performance Planning Card
 - Enter Pre-flight Data
 - Conduct Pre-flight Inspection
 - Perform Engine Start, Run-Up, and Before-Takeoff Checks
 - Prepare Vehicle/Personnel for NBC Environment
2. **TAXI AND TAKEOFF**
 - Perform Ground Taxi
 - Perform Hover Power Check
 - Perform Hovering Flight
 - Perform Takeoff
3. **FLY AIRCRAFT TO/FROM MISSION AREA**
 - Cruise (Non-Tactical Flight)
 - Perform Tactical Flight
 - Monitor Instruments
 - Perform Holding Procedure
4. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
5. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
6. **APPROACH AND LAND AIRCRAFT**
 - Perform Before-Landing Checks
 - Approach
 - Land
 - Taxi

**TABLE 8 - OPERATIONAL FUNCTIONS FOR UTILITY
HELICOPTERS (continued)**

- 7. PERFORM AFTER-LANDING TASKS**
 - Conduct Engine Shutdown
 - Conduct Post-Flight Checks
 - Complete Reports and Forms
 - Conduct Briefing
- 8. COMPENSATE FOR INFLIGHT EQUIPMENT MALFUNCTIONS AND EMERGENCIES**
 - Identify Malfunction
 - Identify Source of Malfunction
 - Compensate/Recover from Malfunction
 - Extinguish Fire
 - Clear Weapon Misfire
 - Evacuate Aircraft
- 9. ACQUIRE TARGETS**
 - Detect/Locate Targets
 - Identify Friend or Foe
- 10. ATTACK TARGET**
 - Maneuver for Attack
 - Select Target(s)
 - Select Weapon
 - Aim/Sight Weapon
 - Track Target
 - Fire Weapon
 - Adjust Fire
 - Egress from Attack Position
- 11. DEFEND AGAINST ATTACK**
 - Deploy to Cover
 - Identify/Locate Source of Threat/Fire
 - Identify/Locate Threat Target Tracking
 - Perform Evasive Maneuvers
 - Employ ECCM
 - Dispense/Disperse Smoke
- 12. LOAD/UNLOAD INTERNAL LOADS**
 - Brief Passengers
 - Load Passengers/Cargo
 - Unload Passengers/Cargo

**TABLE 8 - OPERATIONAL FUNCTIONS FOR UTILITY
HELICOPTERS (continued)**

13. RAISE/LOWER EXTERNAL LOADS

- Attach Load
- Raise Load
- Lower Load

14. PERFORM PARADROP

15. RAPPEL TROOPS

16. PERFORM RECONNAISSANCE

- Move to Recon Area
- Obtain Tactical Information
- Transmit Tactical Report

17. CALL FOR DIRECT SUPPORT

- Call For and Adjust Indirect Fire
- Request/Adjust Illumination
- Adjust Attack Helicopter Fire

TABLE 9 - OPERATIONAL FUNCTIONS FOR SCOUT HELICOPTERS

1. **PLAN AND PREPARE FOR MISSION**
 - Plan Flight
 - Check Load
 - Calculate Weight and Balance Bearing
 - Prepare Performance Planning Card
 - Enter Pre-flight Data
 - Conduct Pre-flight Inspection
 - Perform Engine Start, Run-Up, and Before-Takeoff Checks
 - Prepare Vehicle/Personnel for NBC Environment
2. **TAXI AND TAKEOFF**
 - Perform Ground Taxi
 - Perform Hover Power Check
 - Perform Hovering Flight
 - Perform Takeoff
3. **FLY AIRCRAFT TO/FROM MISSION AREA**
 - Cruise (Non-Tactical Flight)
 - Perform Tactical Flight
 - Monitor Instruments
 - Perform Holding Procedure
4. **NAVIGATE**
 - Identify Present Location
 - Identify Destination
 - Select Travel Route
 - Estimate Time of Arrival and Fuel Requirements
5. **COMMUNICATE**
 - Transmit/Receive Messages
 - Encode/Decode Messages
 - Communicate Using Countermeasure Procedures
6. **APPROACH AND LAND AIRCRAFT**
 - Perform Before-Landing Checks
 - Approach
 - Land
 - Taxi
7. **PERFORM AFTER-LANDING TASKS**
 - Conduct Engine Shutdown
 - Conduct Post-Flight Checks
 - Complete Reports and Forms
 - Conduct Briefing

TABLE 9 - OPERATIONAL FUNCTIONS FOR SCOUT HELICOPTERS

- 8. COMPENSATE FOR INFLIGHT EQUIPMENT MALFUNCTIONS AND EMERGENCIES**
 - Identify Malfunction
 - Identify Source of Malfunction
 - Compensate/Recover from Malfunction
 - Extinguish Fire
 - Clear Weapon Misfire
 - Evacuate Aircraft
- 9. ACQUIRE TARGETS**
 - Detect/Locate Targets
 - Identify Friend or Foe
- 10. ATTACK TARGET**
 - Maneuver for Attack
 - Select Target(s)
 - Select Weapon
 - Aim/Sight Weapon
 - Track Target
 - Fire Weapon
 - Adjust Fire
 - Egress from Attack Position
- 11. DEFEND AGAINST ATTACK**
 - Deploy to Cover
 - Identify/Locate Source of Threat/Fire
 - Identify/Locate Threat Target Tracking
 - Perform Evasive Maneuvers
 - Employ ECCM
 - Dispense/Disperse Smoke
- 12. PERFORM RECONNAISSANCE**
 - Move to Recon Area
 - Obtain Tactical Information
 - Transmit Tactical Report
- 13. CALL FOR DIRECT SUPPORT**
 - Call For and Adjust Indirect Fire
 - Request/Adjust Illumination
 - Adjust Attack Helicopter Fire

**TABLE 10 - OPERATIONAL FUNCTIONS FOR LIGHT AND HEAVY
CARGO TRANSPORT TRUCKS**

- 1. PLAN AND PREPARE MISSION**
 - Receive/Review Order
 - Complete Vehicle Record Forms
 - Perform Pre-Operation Checks
 - Camouflage Vehicle
 - Mark Vehicle
- 2. PREPARE LOAD**
 - Observe/Check Loading of Cargo/Passengers
 - Brief Passengers
 - Secure Load
 - Couple Trailer
 - Load Vehicle
- 3. DRIVE VEHICLE**
 - Start Vehicle
 - Drive Vehicle
 - Drive Vehicle in Motor March or Convoy
- 4. DEFEND AGAINST ATTACK**
 - Deploy to Cover
 - Perform Evasive Maneuvers
- 5. COMPENSATE FOR EQUIPMENT MALFUNCTIONS AND EMERGENCIES**
 - Perform Self-recovery of Vehicle
- 6. LOAD/UNLOAD VEHICLE**
 - Load Cargo/Passengers
 - Unload Cargo/Passengers
- 7. PERFORM POST-MISSION PROCEDURES**
 - Park Vehicle
 - Perform Post-Operation Checks
 - Complete Vehicle Record Forms

TABLE 11 - OPERATIONAL FUNCTIONS FOR GRENADE LAUNCHERS

1. CONDUCT PRE-OPERATION INSPECTION

2. PREPARE WEAPON FOR FIRING

- Assemble Weapon
- Mount Sight
- Zero Weapon
- Zero Sight

3. GET INTO FIRING POSITION

- Load Weapon
- Select Type of Fire
- Select Firing Position
- Get Into Firing Position

4. DETECT/LOCATE TARGETS

- Search for Target
- Detect/Locate Target
- Identify Friend or Foe

5. FIRE WEAPON

- Determine Target Range
- Select Target
- Aim/Sight Weapon
- Fire Weapon
- Adjust/Fire
- Unload

6. PERFORM POST-FIRING TASKS

- Get Out of Firing Position
- Perform Post-Operation Checks
- Disassemble Weapon
- Dismount Sight

7. CLEAR/RECOVER FROM MISFIRE

**TABLE 12 - OPERATIONAL FUNCTIONS FOR MAN PORTABLE
AIR DEFENSE SYSTEMS**

1. CONDUCT PRE-OPERATION INSPECTION
2. PREPARE WEAPON FOR FIRING
 - Prepare Round
 - Ready Weapon for Firing
3. GET INTO FIRING POSITION
 - Select Firing Position
 - Get Into Firing Position
4. DETECT/LOCATE TARGET
 - Search for Target
 - Detect Target
 - Identify Friend or Foe
5. FIRE WEAPON
 - Aim Weapon
 - Track Target
 - Determine Target Range
 - Set Superelevation and Lead
 - Fire Weapon
6. CLEAR/RECOVER FROM MISFIRE
7. PERFORM POST-FIRING TASKS
 - Discard Expended Launch Tube

**TABLE 13 - OPERATIONAL FUNCTIONS FOR MAN-PORTABLE
ANTI-TANK WEAPONS**

1. CONDUCT PRE-OPERATION INSPECTION
2. PREPARE WEAPON FOR FIRING
 - Assemble Round
 - Mount Tracker
3. GET INTO FIRING POSITION
 - Select Firing Position
 - Get Into Firing Position
4. DETECT/LOCATE TARGETS
 - Search for Target
 - Detect/Locate Target
 - Identify Friend or Foe
5. FIRE WEAPON
 - Determine Target Range
 - Select Target
 - Aim/Sight Weapon
 - Fire Weapon
 - Track Target
6. PERFORM POST-FIRING TASKS
 - Get Out of Firing Position
 - Disassemble Weapon
7. CLEAR/RECOVER FROM MISFIRE

**TABLE 14 - OPERATIONAL FUNCTIONS FOR MAN-PORTABLE
INDIRECT FIRE INFANTRY WEAPONS (MORTARS)**

- 1. PERFORM PRE-OPERATION CHECKS**
- 2. PREPARE POSITION**
- 3. PREPARE MORTAR FOR FIRING**
 - Assemble Mortar
 - Lay Mortar
 - Boresight Mortar
 - Perform Pre-Fire Checks
- 4. FIRE MORTAR AT INDIRECT FIRE TARGETS**
 - Receive Firing Order
 - Prepare Ammunition for Firing
 - Set Elevation and Deflection
 - Load Mortar
 - Fire Mortar
- 5. FIRE MORTAR AT DIRECT FIRE TARGETS**
 - Identify Target
 - Select Target
 - Point Mortar at Target
 - Prepare Ammunition for Firing
 - Load Mortar
 - Aim Mortar
 - Fire Mortar
 - Adjust Fire
- 6. PERFORM POST-FIRING TASKS**
 - Perform Post-Operation Checks
 - Disassemble Weapon
 - Displace Aiming Posts
- 7. CLEAR/RECOVER FROM MISFIRE**

TABLE 15 - OPERATIONAL FUNCTIONS FOR AUTOMATIC WEAPONS

- 1. CONDUCT PRE-OPERATION INSPECTION**
- 2. PREPARE WEAPON POSITION**
- 3. PREPARE WEAPON FOR FIRING**
 - Assemble Weapon
 - Mount Sight
 - Zero Weapon
 - Zero Sight
- 4. GET INTO FIRING POSITION**
 - Load Weapon
 - Select Type of Fire
 - Select Firing Position
 - Get Into Firing Position
- 5. DETECT/LOCATE TARGETS**
 - Search for Target
 - Detect/Locate Target
 - Identify Friend or Foe
- 6. FIRE WEAPON**
 - Determine Target Range
 - Select Target
 - Aim/Sight Weapon
 - Fire Weapon
 - Adjust/Fire
 - Unload
- 7. PERFORM POST-FIRING TASKS**
 - Get Out of Firing Position
 - Remove Aiming Stakes
 - Perform Post-Operation Checks
 - Disassemble Weapon
 - Dismount Sight
- 8. CLEAR/RECOVER FROM MISFIRE**

TABLE 16 - OPERATIONAL FUNCTIONS FOR RIFLES

1. CONDUCT PRE-OPERATION INSPECTION
2. PREPARE WEAPON FOR FIRING
 - Assemble Weapon
 - Mount Sight
 - Zero Sight
3. GET INTO FIRING POSITION
 - Load Weapon
 - Select Type of Fire
 - Select Firing Position
 - Get Into Firing Position
4. DETECT/LOCATE TARGETS
 - Search for Target
 - Detect/Locate Target
 - Identify Friend or Foe
5. FIRE WEAPON
 - Determine Target Range
 - Select Target
 - Aim/Sight Weapon
 - Fire Weapon
 - Adjust/Fire
 - Unload
6. PERFORM POST-FIRING TASKS
 - Get Out of Firing Position
 - Perform Post-Operation Checks
 - Dismount Sight
7. CLEAR/RECOVER FROM MISFIRE

APPENDIX B: ACRONYMS AND ABBREVIATIONS

AM	Amplitude Modulation
AMC	Army Materiel Command
ASAS	All Source Analysis System
ASP	All Source Processing
ASVAB	Armed Service Vocational Aptitude Battery
BCS	Baseline Comparison System
BIT/BITE	Built-In Test/Built-In Test Equipment
BOIP	Basis of Issue Plan
BOIPFD	Basis of Issue Plan Feeder Data
BTU	British Thermal Unit
C2	Command and Control
CBT	Computer-Based Training
CFM	Cubic Feet per Minute
CM	Corrective Maintenance
CNI	Copilot Navigation Interface
DDI	Design Difference Index
DoD	Department of Defense
DODIC	Department of Defense Instruction Code
DS	Direct Support
DT/OT	Developmental Testing/Operational Testing
ECU	Environmental Control Unit
EIC	Equipment Identification Code
E-O	Electro-Optical
EW	Electronic Warfare
FCG	Functional Group Code
FLIR	Forward-Looking Infrared Radar
FM	Field Manual. Frequency Modulation
GFE	Government-Furnished Equipment
GS	General Support
HCM	HARDMAN Comparability Methodology
HUD	Head-Up Display
IEW	Intelligence and Electronic Warfare
IFF	Identification as Friend or Foe
IHDSS	Integrated Helmet Display Sight System
IIP	Initial Information Processing
ILSP	Integrated Logistic Support Plan
IV&V	Independent Verification and Validation
JMSNS	Justification for Major System New Start

KM	Kilometer
KG/CM ²	Kilograms Per Centimeter Squared
LCN	Logistics Support Analysis Code
LCSMM	Life Cycle System Management Model
LIN	Line Item Number
LOA	Letter of Agreement
LRU	Lowest Replaceable Unit
LSAR	Logistic Support Analysis Record
MAA	Mission Area Analysis
MARC	Manpower Requirements Criteria
MCAF	Maintainability-Centered Adjustment Factor
MMA	Main Missile Assembly
M[M]BMA	Mean [Metric] Between Maintenance Actions
MOPP	Mission-Oriented Protective Posture
MOS	Military Occupational Specialty
MPH	Miles Per Hour
MPT	Manpower, Personnel, and Training
MR	Maintenance Ratio
MTTR	Mean Time To Repair
NATO	North Atlantic Treaty Organization
NBC	Nuclear, Biological, Chemical
NET	New Equipment Training
OMS/MP	Operational Mode Summary/Mission Profile
O&O Plan	Operational and Organizational Plan
OPSEC	Operations Security
ORG	Organizational
Pam	Pamphlet
PIP	Product Improvement Program
PM	Preventive Maintenance
PMCS	Preventive Maintenance Checks and Balances
POI	Program of Instruction
QQPRI	Qualitative and Quantitative Personnel Requirements Information
R&M	Reliability and Maintainability
RAM	Reliability, Availability, Maintainability
RCAF	Reliability-Centered Adjustment Factor
ROC	Required Operational Capability
RPM	Revolutions Per Minute
SDC	Sample Data Collection
SME	Subject-Matter Expert
SPL	Self-propelled Launcher
SSA	Single Source Analysis
TMDE	Test Measurement and Diagnostic Equipment
TOE	Table of Organization and Equipment
TRADOC	Training and Doctrine Command

UHF	Ultrahigh Frequency
VEL	Velocity
VHF	Very High Frequency
VOR/LOC/ADF	VHF Omnirange/Localizer/Automatic Direction Finder
VOR/MB/GS	VHF Omnirange/Marker Beacon/Glidescope
WHS	Warhead Section
WUC	Work Unit Code

APPENDIX C: GLOSSARY

Additional Skill Identifier (ASI) A code added to the specialty/MOS to designate greater specialization (AR 351-1).

Baseline Comparison System (BCS) A current operational system, or a composite of current operational subsystems which most closely represents the design, operational, and support characteristics of the new system under development (MIL-STD-1388-1A).

Basis of Issue Plan (BOIP) A plan which indicates the quantity of new or modified equipment planned for each type of organization and the planned changes to personnel and supporting equipment (AR 570-27).

Candidate BCS Component Any existing comparable component that satisfies a generic equipment requirement and meets R&M data requirements.

Comparability Analysis The process by which estimates of an emerging weapon system's human-resource requirements are derived from the known requirements of similar operational systems and subsystems.

Component An assembly or any combination of parts, subassemblies, and assemblies mounted together in manufacture, assembly, maintenance, or rebuild (JCS Pub 1).

Corrective Maintenance (CM) The actions performed, as a result of a failure, to restore an item to a specific condition (MIL-STD-721).

Crew Maintenance Maintenance actions that are performed by the personnel whose principal duty is the operation of the system.

Depot Maintenance That maintenance involving the overhaul of economically repairable materiel to augment the procurement program in satisfying the overall Army requirements and when required to provide for repair of materiel beyond the capability of general support maintenance organizations (AR 310-25).

Design Differences The difference in design between projected equipment and comparable existing equipment used in the Baseline Comparison System (BCS).

Direct Support Maintenance That maintenance normally authorized and performed by designated maintenance activities in direct support of using organizations. This category of maintenance is limited to the repair of end items or unserviceable assemblies in support of using organizations on a return-to-user basis (AR 310-25).

Equipment Identification Code (EIC) An alphanumeric coding scheme used to identify specific pieces of equipment, i.e., Functional Group Codes, Work Unit Codes, or Logistic Support Analysis Record numbers.

End-Item Equipment A final combination of end-item products, components, parts, and/or materials which is ready for its intended use, e.g., ship, tank, mobile machine shop, aircraft (MIL-STD-1388-1A).

Function A broad category of activity performed by a man-machine system (Draft MIL-STD on Task Analysis, February 1980). For example, a self-propelled howitzer's upper-level functions would be to shoot, move, and communicate. The shoot function would have such lower-level subfunctions as direct and indirect fire.

Functional Allocation The categorization of the activities (functions) performed by a man-machine system into who or what will perform them. The performance categories include hardware, software, human (operator, supporter, maintainer), or a combination of these categories.

Functional Group Code (FCG) A standard indexing system that parcels the weapon system into its functional systems, subsystems, components/assemblies, and parts.

General Support Maintenance The maintenance authorized and performed by designated Table of Organization and Equipment (TOE) and Table of Distribution and Allowance (TDA) organizations in support of the Army Supply System. Normally these organizations will repair or overhaul materiel to required maintenance standards in a ready-to-use condition based upon applicable supported Army area supply requirements (AR 310-25).

Government Furnished Equipment (GFE) Materiel provided by the Government to a contractor or comparable Government production facility to be incorporated in, attached to, used with, or in support of an end item to be delivered to the Government or ordering activity, or which may be expended in the performance of a contract. It includes, but is not limited to, raw and processed materiel, parts, components, assemblies, tools, and supplies (MIL-STD-1388-1A).

Justification for Major System New Start (JMSNS) A requirements document prepared by the combat developer in coordination with the materiel developer to identify and support the need for a new or improved mission capability. It justifies the initiation of a new major system acquisition or designated acquisition program (DAP) at Program Initiation in the acquisition cycle (AR 71-9).

Letter of Agreement (LOA) A jointly prepared and authenticated document in which the combat and materiel developers outline the basic agreements for further investigation of potential materiel system(s) in response to an approved need (AR 71-9).

Line Item Number (LIN) A number identifying the position which end-item equipment or a component thereof holds in the equipment hierarchy.

Logistic Support Analysis Record (LSAR) That portion of LSA documentation consisting of detailed data pertaining to the identification of logistic support resource requirements of a system/equipment (MIL-STD-1388-1A).

Maintainability A system's or component's need for maintenance, which is determined by multiplying the frequency of preventive and corrective maintenance actions by the time these actions take to complete.

Maintainer The specialist(s) responsible for maintaining the system.

Maintenance Level The four basic levels of maintenance (Organizational, Direct Support, General Support, and Depot) into which maintenance activity is divided (DA Pam 700-127).

Maintenance Ratio A measure of the total maintenance manpower burden required to maintain a system. It is expressed as the cumulative number of man-hours of maintenance expended in direct labor during a given period of time divided by the cumulative number of end items' operating hours during the same time (DA Pam 700-127).

Manpower The total demand, expressed in terms of the number of individuals, associated with a system (MIL-STD-1388-1A). That is, the number of individuals in each MOS, ASI, skill level, and paygrade required to operate and maintain a system.

Manpower Requirements Criteria (MARC) The manpower requirements of positions for Army units as defined by AR 570-2.

Mean Time Between Maintenance Actions The average time (calendar/clock time, hours of operation, miles/kilometers traveled, rounds fired, or number of actuations) between occurrences of demand for maintenance (AR 570-2, under "Mean units between maintenance actions").

Mean Time to Repair (MTTR) The sum of corrective maintenance times divided by the total number of corrective maintenance actions during a given period of time under stated conditions (AR 702-3).

Military Occupational Specialty (MOS) A group of duty positions that require closely related skills such that a person qualified in one duty position in an MOS can, with adequate on-the-job training (OJT), perform in any of the other positions that are at the same level of difficulty.

Mission A clear, concise statement of a task or tasks to be accomplished.

Mission Area A broad subdivision of the Army's overall mission, which is to prepare for, engage in, and win land wars.

Mission Area Analysis (MAA) A study to determine the Army's ability to meet its responsibilities in a given mission area. The lead study to determine requirements for new or improved systems (TRADOC Pam 11-8).

Mission Event Discrete actions that comprise a function.

Mission Profile (MP) A time-phased description of the operational events and environments an item experiences from beginning to end of a specific mission (AR 702-3).

New System (1) The system that is replacing the Predecessor System, and (2) the system being studied in a HARDMAN Comparability Methodology (HCM) analysis.

Obvious BCS Component Any existing comparable component that satisfies a generic equipment requirement, meets R&M data requirements, and clearly fulfills all evaluation criteria.

Operational Mode Summary (OMS) A description of the anticipated mix of way equipment will be used in carrying out its operational role; includes expected percentage of use in each role and percentage of time it will be exposed to each type of environmental condition during the system life. The OMS will not include unscheduled downtime (AR 702-3).

Operator The specialist(s) responsible for operating the system.

Operational and Organizational Plan (O&O Plan) A document that describes how a system will be integrated into the force structure, deployed, operated, and supported in peacetime and wartime (TRADOC Reg 351-9).

Organizational Maintenance (ORG) That maintenance authorized for and performed by a using organization with respect to its equipment (AR 310-25).

Part One piece or two pieces joined together; not normally subject to disassembly without destruction of designed use.

Potential BCS Component Any existing comparable component that satisfies a generic equipment requirement.

Predecessor System An existing system that is performing a mission or missions that will eventually be performed by the New System.

Preventive Maintenance The actions performed in an attempt to retain an item in a specified condition by providing systematic inspection, detection, and prevention of incipient failure (MIL-STD 721).

Product Improvement Program (PIP) Modification or modernization of a program after it has been fielded. PIPs can correct deficiencies, improve performance or capabilities, and extend service life (TRADOC Pam 11-8).

Proposed System An analytical construct used to determine the functional requirements of a New System. It incorporates technological advances likely to exist before the system's projected initial operational capability date.

Qualitative and Quantitative Personnel Requirements Information (QQPRI) A compilation of organizational, doctrinal, training, duty position, and personnel information. It is prepared for new or improved materiel systems by the materiel developer or materiel acquisition agency, in combination with the combat developer and trainer (AR 71-2).

Reliability (1) The duration or probability of failure-free performance under stated conditions, or (2) the probability that an item can perform its intended function for a specified interval under stated conditions (MIL-STD-1388-1A).

Required Operational Capability (ROC) A requirements document prepared by the combat developer in coordination with the materiel developer and approved by HQDA. It states concisely the minimum essential operational, technical, personnel, training, logistic, and cost information necessary to initiate full-scale development or procurement of a materiel system (AR 71-9).

Scenario A brief description of the theater, environment, and threat factors that are likely to be associated with the system missions.

Scheduled Maintenance See Preventive Maintenance.

Subcomponent/Assembly Those parts that comprise the next highest assembly (component/assembly).

Subsystem A major portion of a system that performs a specific function in the overall operational function.

System The combination of people, hardware, and information that, when interacting as a whole, is capable of performing a required mission on the battlefield.

Table of Organization and Equipment (TOE) A table that prescribes the normal mission, organizational structure, personnel, and equipment requirements for a military unit. It forms the basis for an authorization document (AR 310-25).

Task A unit of work activity that constitutes a logical and necessary step in the performance of a job/duty. It is the smallest unit of behavior in a job that describes the performance of a meaningful function in the job under consideration.

Unscheduled Maintenance See Corrective Maintenance.

Usage Rate The amount of system usage in miles driven, rounds fired, hours operated, etc., required over time to accomplish the system's missions.

Workload The amount of work, stated in predetermined work units, that organizations or individuals perform or are responsible for performing (AR 310- 25).

APPENDIX D: HCM-MIST CROSSWALK FOR SYSTEMS ANALYSIS

A direct translation of Hardman Comparability Methodology (HCM) substeps and action steps to the Man Integrated Systems Technology (MIST) procedures and worksheets is not possible. MIST is not an "automated HARDMAN"; however, it is an automated methodology that uses the same input, performs many of the same calculations, and generates similar output and products.

The HCM consists of many step-by-step procedures that must be completed sequentially to generate products. MIST, through automation, combines many of these step-by-step procedures. This combination of procedures is possible because MIST performs all procedures involving mathematical computations. In addition, MIST automatically hands off and receives input/output generated by other procedures within the methodology.

MIST is not as complete as the HCM. For example, MIST does not directly determine operator requirements as does the HCM. MIST also does not compute the Standards of Grade Authorizations and does not handle complex force structures.

The following pages contain a description of the links between the HCM and MIST. As explained above, the links are not direct. They indicated where similar parameters are being considered.

HCM - MIST CROSSWALK FOR SYSTEMS ANALYSIS

Substep	Action Step	Data Elements	MIST Worksheets/Models
1.1	1	<ul style="list-style-type: none"> System Missions 	<ul style="list-style-type: none"> Mission Profile (SRA020)
1.2	1	<ul style="list-style-type: none"> Predecessor System Equipment List 	<ul style="list-style-type: none"> Predecessor System Description (SRA080)
	2	<ul style="list-style-type: none"> New System Documents and Proposed Designs 	<ul style="list-style-type: none"> Organizational, Operational, and Support Concepts (SRA030) System Threat (SRA040) Operational Environment (SRA041)
1.3	1, 2, 3	<ul style="list-style-type: none"> New System Functions 	<ul style="list-style-type: none"> Required New System Functions (SRA050)
	4	<ul style="list-style-type: none"> New System Functional Requirements 	<ul style="list-style-type: none"> Required New System Functions (SRA050)
	5	<ul style="list-style-type: none"> Functional Allocation 	<ul style="list-style-type: none"> None
1.4	1	<ul style="list-style-type: none"> Generic Equipment 	<ul style="list-style-type: none"> Generic System Description (SRA070)

HCM - MIST CROSSWALK FOR SYSTEMS ANALYSIS

Substep	Action Step	Data Elements	MIST Worksheets/Models
1.5	1	<ul style="list-style-type: none"> New System Functions Arrayed Over Time 	<ul style="list-style-type: none"> New System Functional Sequence (SRA060)
	2	<ul style="list-style-type: none"> Mission Events 	<ul style="list-style-type: none"> None
	3	<ul style="list-style-type: none"> Operating Metrics 	<ul style="list-style-type: none"> Usage Rates (SRA179)
	4	<ul style="list-style-type: none"> Usage Rates 	<ul style="list-style-type: none"> Usage Rates (SRA179)
1.6	1, 2	<ul style="list-style-type: none"> BCS Components for Workload Analysis Operational Environment Usage Rates Data Source Information 	<ul style="list-style-type: none"> BCS Candidate Equipment Selection (SRA090) BCS Description (SRA100, 101) Operational Environment (SRA041) Usage Rates (SRA179) Reliability/Maintainability Data (SRA170)
	3	<ul style="list-style-type: none"> BCS Components for Training Analysis 	<ul style="list-style-type: none"> Operator Training Source Index (SRA230) Maintainer Training Source Index (SRA240)
1.7	1	<ul style="list-style-type: none"> New System Designs 	<ul style="list-style-type: none"> None
	2	<ul style="list-style-type: none"> BCS Performance Deficiencies 	<ul style="list-style-type: none"> BCS Performance Shortfall (SRA110)
	3	<ul style="list-style-type: none"> Proposed System Equipment List 	<ul style="list-style-type: none"> New Configuration System Description (SRA120, 121)

HCM - MIST CROSSWALK FOR SYSTEMS ANALYSIS

Substep	Action Step	Data Elements	MIST Worksheets/Models
1.8	1	<ul style="list-style-type: none"> • Operator Tasks 	<ul style="list-style-type: none"> • None
	2	<ul style="list-style-type: none"> • Maintainer Tasks 	<ul style="list-style-type: none"> • Workload (SRA180)
1.9	1	<ul style="list-style-type: none"> • Predecessor System Maintenance Ratios 	<ul style="list-style-type: none"> • Workload (SRA180)
	2	<ul style="list-style-type: none"> • BCS Maintenance Ratios 	<ul style="list-style-type: none"> • Workload (SRA180)
	3	<ul style="list-style-type: none"> • Proposed System Maintenance Ratios 	<ul style="list-style-type: none"> • Workload (SRA180)

APPENDIX E: HCM-MPT DOCUMENTS CROSSWALK FOR SYSTEMS ANALYSIS

The HARDMAN Comparability Methodology, which is an integral component of the Manpower and Personnel Integration (MANPRINT) program, estimates a weapon system's manpower, personnel, and training (MPT) requirements. The HCM can provide valuable MPT information to Army decision makers during the entire weapon system acquisition process.

The HCM can contribute to many Army MPT processes and documents, including:

- Basis of Issue Plan (BOIP)
- Qualitative and Quantitative Personnel Requirements Information (QQPRI)
- System Training Plan (STRAP)
- Army system Acquisition Review Councils (ASARC)
- Logistic Support Analysis (LSA), MIL-STD-13881A
- System MANPRINT Management Plan (SMMP)
- Individual Training Plan (ITP)

The HCM analysis team can make recommendations concerning any of the data elements contained in these documents; however, the Army has final control of the MPT documents. The relationship between MPT documents and the HCM is reciprocal. depending on the New System's location in the weapon system acquisition process, the HCM analysis team will either obtain information from these documents or produce results that could feed these documents. HCM analysis results could be viewed as a test of the data in an MPT document. HCM Tradeoff Analysis can be used to consider alternatives.

The HCM MPT documents crosswalk on the following pages lists the products of Step 1 by action step and the MPT documents that require similar information.

HCM - MPT DOCUMENTS CROSSWALK FOR SYSTEMS ANALYSIS

Substep	Action Step	HCM Products	MPT Documents
1.1	1	<ul style="list-style-type: none"> System Missions 	<ul style="list-style-type: none"> LSA, Task 201
1.2	1	<ul style="list-style-type: none"> Predecessor System Equipment 	<ul style="list-style-type: none"> LSA, Tasks 203 and 302
	2	<ul style="list-style-type: none"> Proposed New System Designs 	
1.3	1, 2, 3	<ul style="list-style-type: none"> New System Functions 	<ul style="list-style-type: none"> LSA, Task 301
	4	<ul style="list-style-type: none"> New System Functional Requirements 	<ul style="list-style-type: none"> LSA, Task 301
	5	<ul style="list-style-type: none"> Functional Allocation 	<ul style="list-style-type: none"> LSA, Task 301
1.4	1	<ul style="list-style-type: none"> Generic Equipment 	<ul style="list-style-type: none"> BOIPFD, 4a BOIP 19b, 20a LSA, Task 203
1.5	1	<ul style="list-style-type: none"> Function Time Lines 	
	2	<ul style="list-style-type: none"> Mission Events 	<ul style="list-style-type: none"> LSA, Task 201
	3	<ul style="list-style-type: none"> Operating Metrics 	<ul style="list-style-type: none"> LSA, Task 201
	4	<ul style="list-style-type: none"> Usage Rates 	<ul style="list-style-type: none"> OMS/MIP

HCM - MPT DOCUMENTS CROSSWALK FOR SYSTEMS ANALYSIS (Continued)

Substep	Action Step	HCM Products	MPT Documents
1.6	1,2	<ul style="list-style-type: none"> BCS Components for Workload Analysis 	<ul style="list-style-type: none"> LSA, Tasks 203, 204 and 205 BOIPFD, 11e BOIPFD, 9 and 12
	3	<ul style="list-style-type: none"> BCS Components for Training Analysis 	
1.7	1	<ul style="list-style-type: none"> New System Designs 	<ul style="list-style-type: none"> LSA, Tasks 203,204,205, and 302
	2	<ul style="list-style-type: none"> BCS Performance Deficiencies 	<ul style="list-style-type: none"> LSA, Tasks 203, 204, and 205
	3	<ul style="list-style-type: none"> Proposed System Equipment 	<ul style="list-style-type: none"> LSA, Tasks 204 and 302 QQPRI, Second Requirement
1.8	1	<ul style="list-style-type: none"> Operator Tasks 	<ul style="list-style-type: none"> LSA, Task 401 TAD
	2	<ul style="list-style-type: none"> Maintainer Tasks 	<ul style="list-style-type: none"> LSA, Task 401 TAD
1.9	1	<ul style="list-style-type: none"> Predecessor System Maintenance Ratios 	
	2	<ul style="list-style-type: none"> BCS Maintenance Ratios 	<ul style="list-style-type: none"> LSA, Task 203
	3	<ul style="list-style-type: none"> Proposed System Maintenance Ratios 	<ul style="list-style-type: none"> LSA, Tasks 203 and 204

APPENDIX F: DATA-SOURCE ANALYSIS

Introduction

In Systems Analysis, Step 1 of the HARDMAN Comparability Methodology (HCM), the engineering analyst uses several data sources to obtain reliability and maintainability (R&M) data for fielded equipment.

This appendix provides an introduction to some of these data sources and describes analytic techniques that the analyst can use to prepare the data for use in Systems Analysis. The analyst should always check with subject-matter experts (SMEs) before he or she uses the techniques discussed in this appendix.

In Systems Analysis, the analyst describes the equipment R&M characteristics in terms of a maintenance ratio (MR). The MR is the product of reliability and maintainability parameters:

$$\text{Reliability} \times \text{Maintainability} = \text{MR}$$

$$\frac{1}{M[M]BMA} \times \text{MTTR} \times K = \frac{\text{Man-hours}}{\text{Metric}} \rightarrow \text{time, rounds, etc.}$$

Where:

M[M]BMA = Mean [Metric] Between Maintenance Action, with the metric expressed in time (MTBMA), rounds (MRBMA), etc.

MTTR = Mean Time to Repair, or the average elapsed or clock time required to complete the action.

K = Number of people required to perform the action.

The analyst must account for direct maintenance, including Preventive Maintenance (PM) and Corrective Maintenance (CM). The analyst should calculate MRs for each maintenance task or maintenance action. However, he or she can determine MRs at that level of detail only if the data source provides the necessary information. The data source must include direct maintenance time by maintenance level and MOS for each piece of equipment. Indirect maintenance time is not addressed in the HCM; therefore, the analyst must extract indirect maintenance time from the data if it is present.

The six primary R&M data sources are:

- 1) U.S. Army Sample Data Collection (SDC)
- 2) U.S. Army RAMLOG
- 3) Navy Maintenance Materiel Management (3M) in microfiche format
- 4) Navy 3M in magnetic tape format

- 5) U.S. Army Materiel Command (AMC) Manpower Authorization Requirements Criteria (MARC) in microfiche format
- 6) U.S. Army Logistics Center (LOGCEN), Army MARC Maintenance Data Base (AMMDB) available in quarterly hard-copy reports or accessed through system 2000 data link

This appendix describes how the analyst performs the following procedures for each data source.

- 1) Assign maintenance to the appropriate maintenance levels (unit and intermediate). The analyst must distribute the source R&M data among the appropriate maintenance levels and MOSs (if applicable).
- 2) Extract Indirect Maintenance. The analyst must extract any indirect or non-direct maintenance from the source R&M data.
- 3) Identify CM and PM. The analyst must separate PM from CM where possible and estimate PM when only CM is available.

Army SDC

Army SDC is a record of maintenance events and repair times or action times. It is collected on fielded systems, usually by an independent corporation contracted by the Army. The completeness of the data for use by HCM depends on the maturity of the New System, the extent of the SDC collection effort, and the accessibility of the SDC data. SDC contains both CM and PM, but they are in separate reports. In the example that follows MRs are calculated from the source data parameters provided. The data in the example consist of R&M parameters for CM Unit maintenance and equipment without maintenance task designations.

Normalization Process

- 1) Assign maintenance to the appropriate maintenance levels. The analyst refers to existing data sources and notes the maintenance distribution relative to the maintenance provided in the source data.
- 2) Extract indirect maintenance time. ARMY SDC does not contain indirect maintenance time.
- 3) Identify CM and PM.

If the analyst needs to distribute indirect maintenance to Intermediate Forward (DS) and Intermediate Rear (GS), he or she should refer to the AMMDB and determines a typical distribution for similar equipment.

Example

System: AH-64A

Equipment Name: Pressurized Air System

Source data parameters:

$$\begin{aligned} \text{AVUM} \quad \text{MFHBMA} &= 28.89 \text{ FH} \\ \text{MTTR} &= 0.90 \text{ hours} \\ \text{K} &= 1.10 \text{ people (average)} \\ \text{MR} &= \frac{1}{28.89 \text{ FH}} \times 0.90 \text{ hours} \times 1.10 \text{ people} \\ \text{AVUM} &= 0.0343 \text{ MMH/FH} \end{aligned}$$

- 1) Assign maintenance to the appropriate maintenance levels.

$$\frac{\text{MR}}{\text{AVUM}} = 0.0343 \text{ MMH/FH}$$

U.S. Army MOS workload study¹ indicated an AVIM to AVUM maintenance distribution ratio of 3.0. After the analyst determines the required MOSs to maintain this equipment, he or she applies this factor.

$$\begin{aligned} \frac{\text{MR}}{\text{AVIM}} &= \frac{\text{MR}}{\text{AVUM}} \times 3.0 \\ &= 0.0343 \times 3.0 \\ &= 0.1029 \text{ MMH/FH} \end{aligned}$$

- 2) Extract Indirect Maintenance. Not applicable.
- 3) Identify CM and PM. This example does not include PM; the analyst must therefore develop it. The factors (F) presented in the example were derived from the Marine Corps' AH-1T helicopter data, where PM and CM were recorded and indicated separately.

For Unit maintenance:

$$\begin{aligned} \text{MR (PM)} &= \text{MR (CM)} \times F \\ F &= 0.56 \end{aligned}$$

¹ 1 MARC Factors for LHX Cost and Operational Effectiveness Analysis (COEA). September 25, 1987. Jeanette Z. Walker (Letter).

For Intermediate maintenance:

$$MR (PM) = MR (CM) \times F$$

$$F = 0.20$$

$$\begin{aligned} \text{AVUM } MR_{PM} &= MR_{CM} \times 0.56 \\ &= 0.0343 \times 0.56 \\ &= 0.0192 \text{ MMH/FH} \end{aligned}$$

$$\begin{aligned} \text{AVIM } MR_{PM} &= MR_{CM} \times 0.20 \\ &= 0.1029 \times 0.20 \\ &= 0.0206 \text{ MMH/FH} \end{aligned}$$

Total Direct MRs

$$\begin{aligned} \text{AVUM } MR_{DIR} &= MR_{CM} + MR_{PM} \\ &= 0.0343 + 0.0192 \\ &= 0.0535 \text{ MMH/FH} \end{aligned}$$

$$\begin{aligned} \text{AVIM } MR_{DIR} &= 0.1029 + 0.0206 \\ &= 0.1235 \text{ MMH/FH} \end{aligned}$$

U.S. Army RAMLOG

Army RAMLOG data are a record of maintenance events and repair times or action times. These data are collected during the operational-testing phase of a system's development, usually by an independent corporation contracted by the Army. The data-collection process is very thorough; it involves collecting maintenance records and includes on-site timing of the maintainer as the equipment is being repaired. Direct maintenance is recorded (including both CM and PM). The data collected by Army RAMLOG reflect systems that may or may not be fully developed for fielding. Because the data are gathered in a test environment, the data may be deficient in induced reliability characteristics. In terms of data parameters, RAMLOG reports are very similar to SDC reports.

For example purposes, assume the induced reliability characteristics have been captured. The data manipulation becomes identical to that of SDC, given the same R&M parameters:

- 1) Unit maintenance only.
- 2) Equipment without maintenance task designations.
- 3) CM only.

Normalization Process

Same as SDC.

Example

System: AH-64A

Equipment Name: Pressurized Air System

Source data parameters:

$$\begin{aligned} \text{AVUM} \quad \text{MFHBMA} &= 18.95 \\ \text{MTTR} &= 0.32 \\ K &= 1.00 \text{ people (average)} \\ \text{MR} &= \frac{1}{18.95 \text{ FH}} \times 0.32 \text{ hours} \times 1.00 \text{ people} \\ \text{AVUM} &= 0.0169 \text{ MMH/FH} \end{aligned}$$

- 1) Assign maintenance to the appropriate maintenance level.

$$\begin{aligned} \text{MR} &= \text{MR} \times 3.0 \\ \text{AVIM} \quad \text{AVUM} &= 0.0169 \times 3.0 \end{aligned}$$

$$\begin{aligned} \text{MR} &= 0.0507 \text{ MMH/FH} \\ \text{AVIM} \end{aligned}$$

- 2) Extract indirect maintenance. Not applicable.

- 3) Identify CM and PM.

$$\begin{aligned} \text{AVUM} \quad \text{MR} &= \text{MR} \times 0.56 \\ \text{PM} \quad \text{CM} &= 0.0169 \times 0.56 \\ &= 0.0095 \text{ MMH/FH} \end{aligned}$$

$$\begin{aligned} \text{AVIM} \quad \text{MR} &= \text{MR} \times 0.20 \\ \text{PM} \quad \text{CM} &= 0.0507 \times 0.20 \\ &= 0.0101 \text{ MMH/FH} \end{aligned}$$

Total Direct MRs

$$\begin{aligned} \text{AVUM} \quad \text{MR} &= \text{MR} + \text{MR} \\ \text{DIR} \quad \text{CM} \quad \text{PM} &= 0.0169 + 0.0095 = 0.0264 \text{ MMH/FH} \end{aligned}$$

$$\begin{aligned} \text{AVIM} \quad \text{MR} &= 0.0507 + 0.0101 = 0.0608 \text{ MMH/FH} \\ \text{DIR} \end{aligned}$$

NOTE

When the resulting MRs and SDC MRs are compared, RAMLOG's deficiencies are readily apparent.

Navy 3M Microfiche

Data Base Manager

For Non-Aircraft data: The Navy Ships Parts Control Center (NSPCC)
For Aircraft data: The Maintenance Support Office Department (MSOD)
Location: Mechanicsburg, PA

Navy 3M data include direct maintenance (CM and PM) and indirect maintenance, including "make ready-put away" maintenance time. These data also provide the total R&M parameters for Squadron and Intermediate combined. The total maintenance man-hours per flight hour (MMH/FH) are recorded. When the analyst applies Navy data to Army systems, he or she should understand that Squadron is synonymous with AVUM and Intermediate is synonymous with AVIM.

Normalization Process

- 1) Assign maintenance to the appropriate maintenance levels. An analysis of Navy data with Squadron and Intermediate data reveals these results:

For Avionics:	Squadron averages 56.4 percent of the total maintenance reported. Intermediate averages 43.6 percent of the total maintenance reported.
For Non-Avionics:	Squadron averages 72.3 percent of the total maintenance reported. Intermediate averages 27.7 percent of the total maintenance reported.
- 2) Extract Indirect Maintenance. As noted previously, Navy 3M includes indirect maintenance time. An analysis similar to that described above reveals these results: Indirect and "make ready-put away" maintenance accounts for 35.9 percent of the Squadron total maintenance and 16.7 percent of the Intermediate total maintenance. 3) Identify CM and PM. Procedures 1 and 2 yield MRs for direct maintenance (including CM and PM). The analyst can isolate CM and PM by referring to other data sources for similar equipment where CM and PM are reported separately.

Example

System: AH-1T
Equipment: AH/APR39(I)(v) Radar Detecting Set
Source data parameters:

Total UNSCH MMH/FH = 0.061 MMH/FH

- 1) Assign maintenance to the appropriate maintenance levels.

$$\begin{array}{lcl} \text{Avionics} & F & = F = 0.564 \\ & \text{Squadron} & \text{AVUM} \\ & F & = F = 0.436 \\ & \text{Intermediate} & \text{AVIM} \end{array}$$

Total MR

$$\begin{array}{lcl} \text{MR} & = 0.061 & \times F = 0.061 \times 0.564 = 0.0344 \\ \text{AVUM} & \text{T AVUM} & \\ \text{MR} & = 0.061 & \times F = 0.061 \times 0.436 = 0.0266 \\ \text{AVIM} & \text{T AVIM} & \end{array}$$

- 2) Extract Indirect Maintenance (includes "make ready-put away").

$$\begin{array}{lcl} F & = F & = (1 - 0.359) = 0.641 \\ \text{Flt. Line} & \text{AVUM} & \\ F & = F & = (1 - 0.167) = 0.833 \\ \text{Shop} & \text{AVIM} & \end{array}$$

DIRECT MR

$$\begin{array}{lcl} \text{MR} & = \text{MR} & \times F = 0.0344 \times 0.641 = 0.0221 \text{ MMH/FH} \\ \text{D AVUM} & \text{T AVUM} & \text{AVUM} \\ \text{MR} & = \text{MR} & \times F = 0.0266 \times 0.833 = 0.0222 \text{ MMH/FH} \\ \text{D AVIM} & \text{T AVIM} & \text{AVIM} \end{array}$$

Navy 3M Magnetic Tape

These Navy 3M data originate from the same source as the Navy 3M Microfiche. This report generates a more detailed report that indicates Squadron and Intermediate maintenance events separately.

Normalization Process

- 1) Assign maintenance to the appropriate maintenance levels. Not applicable.
- 2) Extract Indirect Maintenance. Same as Navy 3M Microfiche.

$$\begin{array}{lcl} F & = 0.641 & F = 0.833 \\ \text{AVUM} & & \text{AVIM} \end{array}$$

Example

System: AH-IT

Equipment: AN/APR39(v) Radar Detecting Set

Source Data Parameters:

$$\text{Total Squadron MMH/FH} = 0.035 = \text{MR}_{\text{T AVUM}}$$

$$\text{Total Intermediate MMH/FH} = 0.058 = \text{MR}_{\text{T AVIM}}$$

- 1) Assign maintenance to the appropriate maintenance levels. Not applicable.
- 2) Extract indirect maintenance (includes "make ready-put away").

$$\text{MR}_{\text{D AVUM}} = \text{MR}_{\text{T AVUM}} \times \text{F}_{\text{AVUM}} = (0.035 \times 0.641) = 0.0224 \text{ MMH/FH}$$

$$\text{MR}_{\text{D AVIM}} = \text{MR}_{\text{T AVIM}} \times \text{F}_{\text{AVIM}} = (0.058 \times 0.833) = 0.0483 \text{ MMH/FH}$$

AMC MARC

AMC MARC provides Direct Productive Annual Maintenance Man-Hours (DPAMMH) sorted by Line Item Number (LIN), maintenance level, and MOS. It often provides the equipment's annual usage rates. AMC MARC indicates the source of data. Some of these sources are based on estimates.

Normalization Process

- 1) Assign maintenance to the appropriate maintenance levels. Not applicable.
- 2) Extract indirect maintenance. Not applicable. AMC MARC records direct maintenance only.

Normalization of AMC MARC data is not necessary. Given the DPAMMH and the annual usage rate, the calculation of the MR becomes:

$$\text{MR} = \text{DPAMMH}/(\text{usage metric}/\text{year})$$

Example

Equipment name: Radar Set AN/MPQ-4A

LIN: Q15414

Source data parameters:

Maintenance Level			
<u>MOS</u>	<u>Unit</u>	<u>IDS</u>	<u>IGS</u>
39C	252.0	154.0	262.0

Annual Usage Rate: 4320 hours/year

MR Calculations:

<u>MOS</u>	<u>Unit (MMH/OH)</u>	<u>IDS (MMH/OH)</u>	<u>IGS (MMH/OH)</u>
39C	252.0/4320.0	154.0/4320.0	262/4320.0
	= 0.0583	= 0.0356	= 0.0606

USALOGC, AMMDB

These data are available in two forms for HCM use. One form is a report printed quarterly; the other form provides the most current data available and is available by accessing the System 2000 data link. Both sources originate from the same data base; however, more data elements are available through the System 2000 data link. USALOGC AMMDB does not record annual usage rates. USALOGC AMMDB data include indirect maintenance, which is added in by applying indirect productive time (IPT) factors. These factors are MOS dependent and are recognized by the U.S. Army as standard. The factors are displayed in Table 1.

Table 1²

	<u>UNIT/ AVUM</u>	<u>IDS/ AVIM</u>	<u>IGS/ SRA</u>
AHS (MOS 35G and 35U).	1.2	1.2	1.2
ADA (MOS 24C, 24E, 24G, 24M, 24N, 24S, 24T, 24U, 25L, 26H).	1.36	1.36	1.35
OMMS (MOS 21L, 24H, 24J, 24K, 24L, 27B, 27C, 27D, 27E, 27F, 27G, 27L, 27M, 27N, 46N, 55B, 55D, 55G, 55X).	1.36	1.35	1.35
All other MOSs.	1.4	1.4	1.22

The analyst would change F43414 to DPAMMH and would look up LIN F43414 in the AMMDB. The analyst would see that F43414 is supported by MOS 62B, at all three levels of maintenance. The hours listed are Unit 1215.0, IDS 297.0 and IGS 129.3. Since MOS 62B falls under all others, the analyst will use IPT factors 1.4, 1.4, and 1.22. The computations will look like this:

² 2 Army MARC Maintenance Data Base, September 1986.

<u>LIN</u>	<u>MOS</u>	<u>UNIT</u>	<u>IDS</u>	<u>IGS</u>
F43414	62B	1215.0	297.0	129.3

1215.0 Div by 1.4 = 867.85 DPAMMH = 867.9 (UNIT)
 297.0 Div by 1.4 = 212.14 DPAMMH = 212.1 (IDS)
 129.3 Div by 1.22 = 106.0 DPAMMH = 106.0 (IGS)

Normalization Process

The steps for normalizing these data are:

- 1) Remove indirect maintenance by dividing AMMHs by the IPT factors (see Appendix A).
- 2) Determine the annual usage rate. Refer to the AMC MARC data or acquire input from the Army on the operating mode of the equipment when the data were collected.

Example

Equipment Name: Radar Set AN/MPQ-4A

LIN: Q15414

Source data parameters:

Maintenance Level			
MOS	Unit(AMMH)	IDS(AMMH)	IGS(AMMH)
39C	352.8	215.6	319.6

- 1) Remove indirect maintenance.

IPT factors: 1.4 for Unit and DS
 1.22 for IGS

Direct maintenance calculations:

MOS	Unit(DPAMMH)	IDS(DPAMMH)	IGS(DPAMMH)
39C	352.8/1.4 = 252.0	215.6/1.4 = 154.0	319.6/1.22 = 262.0

- 2) Determine annual usage rates. These DPAMMHs equal those reported in AMC MARC. Therefore, the analyst can assume that the same annual usage rate of 4,320 hours/year applies. This determination is not always straightforward and more in-depth investigation may be required.
- 3) Direct MR calculations.

Maintenance Level			
MOS	Unit(MMH/OH)	IDS(MMH/OH)	IGS(MMH/OH)
39C	252.0/4320.0 = 0.0583	154.0/4320.0 = 0.0356	262/4320.0 = 0.0606

Summary

The above discussion should serve as a starting point for manipulating data sources. The factors it has discussed can be used; however, they do not replace the need for complete data and should not be relied on to replace data-collection efforts. Interested analysts should investigate these data sources and familiarize themselves with their contents. Any factor used in an HCM analysis must be reviewed with the Technical Advisory Group (TAG).